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BENEFITS OF CANADIAN RECIPROCITY.

By Erastus Wiman.

THAT there are children now born who will live long enough to see the people of the United States number from 150,000,000 to 200,000,000 is a consideration that should have great weight in contemplating the conditions that now are beginning to prevail. If, in the ten years just closed, the population has increased at a rate of nearly 25 per cent. and we now start out with 65,000,000, fifty years at the same rate of progression will bring the population up to very nearly 200,000,000. But, even if the same rate is not maintained, and if only 150,000,000 is reached, this enormous growth will have consequences of a character that should now be considered, with special reference to enlarged territory and widened area of opportunity. There is hardly anything more certain under the sun than this growth, and its certainty should deeply impress every one who thinks at all with the importance of making preparation for an increase so momentous.

Opportunity is the best heritage ever left to the American people. If every American boy at the Revolution had been left a fortune by a British relative, the United States would never have occupied the place it does to-day. If, however, with all the energy possible, and all the stimulant of necessity existing, there had not been abundant opportunity, neither would the nation ever have arisen to its present great attainment in wealth, force, and power. Truly, as Emerson has said, "America is another name for opportunity," and grandly have the American people made the most of it. It makes one feel as if to live in such an age and among such a people is indeed a benediction, and to be distinguished in it is to

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have a decoration beside which all other decorations sink out of sight.

But the question to consider is: What will be the measure of opportunity for the future? Compared with the last four or five generations, what are the chances for the next four or five? How will it be for boys that grow up during the period wherein the population is approaching 150,000,000? The avenues of effort, even in this year of 1892, are pretty well crowded. It is pretty hard work to get into a business now in which competition does not destroy all possibility of profit. The rank and file of business men will admit that the old motto which alleged that "competition is the life of trade" has been reversed. It is now the death of profit. So in the professions there are more lawyers and doctors than are needed, and the mills of learning are grinding out a yearly supply of these in far greater proportion than the increase in population. If this crowded condition exists among business men, if it is reflected in the professions, it is even more painfully evident in the widened area of labor. Strikes and organized demands are the evidences of unrest and discontent at the congested conditions that prevail, while the enormous arrivals from foreign shores, added to the large natural increase in the laboring population, year by year, intensify the situation. Overproduction in manufactures, as the result of a stimulating national policy, is well-nigh universal. Boots and shoes for 100,000,000 of people; collars and cuffs for 150,000,000; woolen goods for twice the population, which, with other disabilities, have destroyed all vestige of profits,—these, together with a proportionate production in all other branches, are the results attained in the closing decade of the first half century of real industrial activity of this people.

Such a condition has already been reached that it is only by consolidation that money can be made, and the great and distinctive feature of the time, next to the possibility of enormous production, is the fact that, in so many leading lines of production, trusts, corners, and combinations successfully prevail. Legislation against this tendency has been invoked in vain. The press, the pulpit, and the public have condemned to no purpose a policy that was essential to the existence of industries threatened by "unbridled competition" on the one hand and a market already restricted on the other. These combinations have come to stay, and they are likely to exist in still greater number until almost all departments of industrial activity will be regulated by them.

The marked features of the time being, therefore, so characteristic of profitless competition, of consolidation to eliminate competition, of congestion in labor, and consolidation in railroads, we come back to the inquiry how these conditions will affect the future when the population has reached 150,000,000. This inquiry derives additional force from the fact that, up to this period, there has been an ever-widening area of territory awaiting occupancy for people, for trade, and for traffic. If, with new territory ever opening up, with new States yearly added to the galaxy of commonwealths that so adorn the western world, this congested condition has been reached, what is likely to be the result now that limitations in the area of occupancy are in sight? If every family that moved west and every emigrant that crossed the sea found a farm ready to be "tickled with the hoe and to laugh with the harvest"; if all these became ready-made customers for merchants and manufacturers because there was plenty of land to be taken up,—what will be the condition of this constant growth in production, this forceful increase in population, when it is realized that within the limitations of the rain-belt there are few farms to be afforded without displacing some existing farmer?

If the emigration sets in eastward from the Rocky Mountains, and meets the enormous stream of humanity from the ocean that, because of war and high-priced food products hereafter likely to prevail in Europe, will seek these shores, then will occur conditions that are likely to intensify the congesting tendency of the times to a startling extent. This tendency has an early intimation in the figures of the Census, which shows that, in this agricultural country, in this country of farms, of prairies and plantations, of mines, of timber and fishing industries, in this country of enormous areas, there is found an increase of 60 per cent. in the cities and only 14 per cent. in the farming districts; and that, while the whole population has increased nearly 25 per cent., it has increased in the cities at a rate over double the average growth.

There is hardly a sign of the times apparent to intelligent observers but points in the direction of lessened opportunity for the next generation on the one hand, and of congestion in population, of competition in the avenues of effort, and a restricted area on the other. Under such circumstances, is it not well to consider what plans can be adopted in the immediate future to remedy as far as possible the difficulties that impend, and contribute to their mitigation in the largest degree?

The prediction does not seem a vain one that in ten years we will cease to export wheat and in twenty we will need to import it, judged as it may be by the certain increase in the demand and the uncertain area upon which it is possible to produce the increase. The growth of population is as certain as the sun, the growth of food producing area has reached its limit, and it will need a revolution in modes of culture, with the occupancy of all waste places, to keep up with the increased demand that is certain to set in. Even with this revolution and this occupancy, the future food supply will be inadequate for the enormous increase in the demand that impends, *unless outside territory is made available.*

It is in a contiguous and outside territory that the remedy may be found for the important adverse conditions which exist for the generation yet to come. The broadened opportunity which the American people now need is to be found in foreign soil, outside their own country. The hope of the future, now that limitations have been reached in production, in manufactures, in area, and in markets, is to seek, as other countries seek, outside lands with which to trade, in whose developments a profit may be shared, and from whom can be gained a contribution to the greatness and wealth of the United States second only to that which within the Union the century now closing has produced.

Of all the countries that could thus contribute to the wealth and prosperity of the United States, Canada stands the highest, as she is the nearest. Greater in area than the United States, with resources scarcely less varied and of a character largely supplemental to the needs of the Republic to the South, the Dominion of the North occupies a relation to the future growth of the continent extremely important, and quite as fruitful of consequences to the people of the Union as to the people of the Canadian Confederation. Certain it is that, if there is a need to open new avenues of commerce; if commercial supremacy is to be maintained; if there is to be a widened opportunity for the young men of the future; and, further, if there is to be room on the continent for the new immigration destined for these shores, and new sources of food-supply for the world created,—these things must be effected by the development of the vast resources of Canada. These resources are happily vast enough, and of a character sufficiently attractive, to incite a people even so great as those of the United States to the highest efforts. The results that will attend their fullest development in the shape of additions to the wealth of the world are to

be measured only by what has been achieved in the United States.

It is therefore most fortunate for the people of this Republic, exhausted as are their areas, and preëmpted as are their opportunities, that right beside them is a country equal to their own in size, possessing potentialities of wealth second only to her own, and ready for an expansion of trade of continental dimensions. Fortunate, too, for the United States that right beside them should

CANADA'S IMPORTANCE ON THE MAP OF NORTH AMERICA.

exist this great land, so that, keyed up as they are to a rate of progress in manufactures, in railroad building and equipment, in production of machinery, and in all that goes to make up a progressive commercial community, there may be room for growth at the pace heretofore set, to the end that the new century may not witness a decline in percentages of increase from those which the last decades of the old centuries set in motion.

All the natural resources to keep this great community in motion exist in Canada. As sources for food supply Canada possesses requisites for even a greater output than in the United States. In iron, copper, nickel, gold, and silver; in coal on the Atlantic and Pacific and midway across the continent; in fisheries unapproached by those of any nation in the world; in timber in unlimited supply; and above all in agricultural areas of the widest and most productive character,—the Dominion of Canada possesses just the things most needed by the United States, and in localities more desirable for her greatest need than could be otherwise provided, except by a Divine Providence having in mind the creation of a great nation on its southern border.

In ancient times the countries of the old world sent out their adventurous traders to discover new worlds for the purposes of trade. Columbus, Cabot, Magellan, Sir Walter Raleigh, Drake, and a host of others added to the world's wealth by their distant journeys, and the trade and development that followed their discoveries. Even in later years Livingstone and Stanley opened up a new continent, which England and Germany carved in two for the purposes of trade. Up to this time the United States, having within themselves a world of their own, have not found it necessary to reach out beyond their own limits. But now that these limits are beginning to be felt in extent of area, in absorption of manufactures, and in production generally, the necessity arises for outside fields of effort. Under such circumstances, where under the sun could a country more desirable be found than Canada, into which to extend the same energy, the same enterprise, and the same measure of development that have achieved a success so marked in the United States? Accessible at every point, on a border line unparalleled in length, with no natural barriers except rivers and lakes, that instead of barriers should be bonds to unite them, the two countries are perfect complements of each other, interlacing each other at numerous points, and with an ability to supply each other with just what each needs. Never in all history were natural conditions more favorable for trade, for interchange, for development, than between the two peoples that together occupy this continent in common. Speaking the same language, bound together by ligatures of social life and by material means of communication, it only needs that there should be removed the customs line that exists, which, like a barbed wire fence, separates them, to make them practically the same people and the same nation, as far

as trade and commerce are concerned. It is the purpose of Reciprocity to remove this barrier and to create between the English-speaking nations of this continent that which, though it cannot be political union, can be the next best thing,—a practical commercial union.

There are those, however, who would postpone even this commercial alliance in the expectation that by thus postponing there will follow a political union. Those who understand the real conditions that prevail in Canada and appreciate all that it means to Great Britain to contemplate a severance between the mother country and her greatest colony do not believe that a political union is possible. Certainly it is impossible for many a year to come, even if it is ever consummated. There are those who strongly believe that at present, at any rate, it is unnecessary, so far as trade and commerce are concerned, for trade and commerce know no political boundaries. There are others who believe that, while it is unnecessary, annexation is equally undesirable in the present condition of both countries; and still further those who believe it is unnecessary and undesirable equally believe it is impossible in the present generation under difficulties so great. So far as a political union is concerned, and with such an uncertainty as to the eventual result, it seems the utmost folly to postpone the closest commercial relation which it is possible to create between the two occupants of the continent. Certainly, the advantages to Canada of such a market as the United States affords would be of the most attractive character. An alliance with a people so progressive, with enterprise so great, capital so abundant, and bursting their own bonds with a desire for still larger achievements in development and in the creation of new regions in which to trade, would be an event of consequences so stupendous as to almost baffle human estimate. So far as the United States is concerned, no greater boon could be granted by a Divine Providence than the opening up of the "greater half of the Continent" to the operation of the same spirit of progress that has thus far animated this people, and to afford fields of effort for the vast number of people from foreign shores that are bound to come in this direction, aiding them to develop in northwestern Canada a region of wheat-producing areas that would supply every mill, load every railroad and lake craft, and create a vast community of ready-made customers second only in purchasing and paying power to those who in Minnesota and the Dakotas have built up the great cities and industries

of the northwest. This is all possible under reciprocity, and more.

The benefits of obliterating the barrier now athwart the continent would be equally great between Massachusetts and the maritime Provinces, equally between Vermont and Quebec, between New York, Pennsylvania, and Ohio and Ontario, as also between British Columbia and the Pacific States. In scope or breadth of achievement, in value of interests advanced, and in number of people favorably affected, no measure in the history of legislation or diplomacy promises so much as does Unrestricted Reciprocity with Canada.

ARCHITECTURE IN WOOD—A PROTEST.

By Gordon B. Kimbrough.

THAT there is a strong aspiration for a new style of architecture in the United States should be manifest to every observer. It is evident in innumerable signs. It is seen in the propensity to so modify the standard and classic styles that what should be good and commendable is often made not only grotesque in proportion but fairly hideous with incongruous and unmeaning decorations. We have scores and hundreds of pretentious buildings which have a basis in the truly artistic principles of design, but which are so covered with new conceits that even the foundation has almost disappeared.

Of course, there can be no reasonable hope for the conception of a new style, using the word style, in this case, in the limited sense in which it is used in the architectural glossary, and not in the broader sense accepted in other arts where it is made to signify everything individualistic in manner. All the fine arts are full grown; and architecture, as the oldest of these arts, is not only full grown but fully matured. One might as well try to draw the outlines of a new man totally unlike the standard man already in being as to try to draw a house borrowing nothing from one of the three recognized types of architectural construction. An artist may draw the new man, but he will always find it necessary to make use of the old material. He may cut off the head if it suits his fancy ; but if he expects the new man to be complete he will be compelled to place the decapitated object under the arm, or at some other point of the torso. The nearest representation of a new man to be discovered anywhere will be foundin journals devoted to caricature; and there is a complete parallel between the features of these journals and the works of some of those architectural designers who are most urgent in the pursuit of a new style.

But while there can be no new style of architecture, American architecture has some peculiarities which have always kept it distinct from the architecture of Europe, and given it a national character at times rather tasteful and at other times sadly the reverse of tasteful. These peculiarities have grown from the material used. Wood has entered so largely into the construction of American

houses that it may be called the chief material of our architects. In country districts the stone or brick house has always been exceptional; in large sections of some of our largest cities such buildings are still comparatively rare; and even where fireproof construction is attempted we still find interior decorations made almost exclusively of wood. Even in the days of Colonial architecture, when brick or stone was thought the only proper material for first-class houses whether in town or country, the decorations, both within and without, were chiefly of wood. In some of the old plantation houses of lower Maryland, built more than one hundred and fifty years ago, may still be seen wainscoting, wrought by the carver, which for superficial surface of woodwork rivals the decorative work placed in rooms finished since the cabinet-maker became an architect and began to contribute his machine-made products to architectural decoration.

It cannot be said, however, that the influence of wood has been anything but mischievous on the development of taste in building. Many centuries ago the European continent, like the modern American continent, was a land of forests sparsely covered by a population who also built mainly of wood, and whose estheticism we should condemn as barbaric. Yet it is easy to imagine that these primitive people produced finer examples of artistic interiors than this country has ever been able to show in the same material. We know, indeed, that the artist was a more important workman among the builders of the dark ages than he has ever been in this country; for specimens of his work, snatched from all the elements of destruction except time, have been preserved in European museums, and they turn the best of our decorative efforts into foolishness. Yet they were only very foolish barbarians after all, those old artists who would consent to exhaust their labor on such a perishable surface. We can even make a merit of our crude taste, and credit the lack of artistic sensibility to a keener perception of the incongruity between product and material.

There are various objections to the use of wood as a building material. In the first place it is entirely inadequate to a full expression of the sentiment that inspires either of the three recognized types of architectural design. It cannot be fashioned into the lines of either the Gothic or the Romanesque style without an imitation that would be at once trivial and unmeaning. It is suitable only for the square lintel of the Greek style; but even when used in the construction of a building in this style the builder must

pause after the material has been converted into windows and doors that are not absolutely incongruous in effect. He must be very careful that he does not try to express anything beyond mere prettiness in details. An attempt to realize grandeur either in masses or lines must always look very much like burlesque. The best that can be said for a building in wood is that it is not always absolutely lacking in dignity; but the word pretty is about the only word that can be used consistently when defining the esthetic impression derived from such a structure. Some buildings of wood can be said to look pretty if the house painter is kept assiduously at work giving them an appearance of brightness and cleanliness.

But it will not be worth while to waste much time in the condemnation of wood as an exclusive material for use in the construction of buildings designed to represent a high order of architectural merit. It is probable that there will be only a few architects who will undertake to defend its use as a chief material for house building, and these few will admit that it is only suitable for suburban or country homes and outhouses. It will generally be conceded that, esthetically as well as structurally, wood is an inferior material to brick or stone; but many architects will plead their impotence in opposing its use against the demand for economy on the part of employers. Were they to insist on the use of only the better material they would draw very few plans. They would soon see themselves supplanted by the common house builder, who would copy old plans with only the addition of new enormities. Thus they would become passive contributors to the degradation of art rather than esthetic reformers.

Doubtless there would be too much to justify this defense; but it does not quite cover the responsibility of the architect. It is not in the use of wood as an exclusive building material for everything above the foundations of buildings that we find it most mischievously at work corrupting the popular taste and preparing the conditions for prolonging its architectural services. The greatest harm is done by encouraging its use as a decorative material on structures that are built without much regard to cost, and which may be said to set the fashion in architecture. Like everything else the building art must confess fealty to fashion, that universal tyrant who passes the whole world beneath his yoke, and whose rule will always be found especially oppressive in all concerns that have any domestic significance.

By what right has the cabinet-maker with his molding ma-

chines usurped the place that should belong exclusively to the artist? Is the interior of a costly building a proper place for the exhibition of flimsy effects, and of decorations that are suggestive of nothing else so strongly as of their perishable nature? We hear a world of nonsense about the beauty of natural woods when used for interior decoration. But does their beauty compare with the beauty of natural stone? Go from the finest of the cabinet-made interiors of New York, a city that prides herself upon the beauty of her cabinet work, and then walk through the corridors of the Hotel Savoy, or any of the few buildings with properly finished interiors. The contrast is so great that one is almost ready to lose patience with a person heard speaking of the beauty of natural woods unless he is a naturalist and free from the suspicion of a design of corrupting artistic morality. Even the house of Robert Garrett, in Baltimore, a building finished in part in endolithic marble, sets a good example to the wood-workers of the period. It is impossible to institute a comparison between the delicately shaded and beautifully toned surface of colored marble, expressive at once of beauty, strength, solidity, and durability, and the flimsy pretense of beauty that veneers the finest of cabinet work. Even marbled slate, polished granite, or stucco appeals more forcibly to good taste in architectural construction than natural wood.

The superiority of marble over all other material for interior decoration may be taken for granted. Doubtless the expense of the finest colored marble is great; but it would be in better taste to use some of the money expended on showy exteriors in its purchase and preparation than to inclose within showy exteriors tawdry and cheap interior decoration. It is simply vulgar to save money in the interiors of buildings for the purpose of producing more showy exteriors. It cannot be said, therefore, that the consideration of economy justifies the use of wood. The consideration of economy in fact demands its banishment. Fireproofing devices would be unnecessary were the use of wood abandoned, and this would cause a very considerable saving. A properly proportioned expenditure within and without, and a building built without any combustible material, would be more economical than an improperly proportioned expenditure imperilled by imflammable woodwork.

This strengthens the question on the responsibility of the architect. Can he justify himself for pandering to the perverted taste for wood interiors when making plans for buildings of the first class? The question must be answered in the negative. The

architect may not be omnipotent, but he is not without influence. It is even possible for him to make wood interiors generally unfashionable by simply maintaining that they are untasteful, and not the proper finish for buildings of any architectural pretensions. He complains that he meets with too much interference on the part of employers. But the interference is usually caused by considerations of greater economy, convenience, or profit, and it is rarely due to any assumption of superior taste. Few men, and still fewer women it is to be feared, do their own thinking even on subjects that they ought to understand; and still fewer will try to do their own thinking against established canons and recognized authority. In these days of technical organization it should be very easy for the architects working together to restore the transient period when good architectural taste received an introduction in the fashionable houses in the neighborhood of Washington Square, New York, but which was afterward expelled from society by the uptown new people.

This is a matter of great importance not merely in architecture but in political economy. Mr. Edward Atkinson called attention in a recent number of this magazine to the frightful annual loss of property in the United States through the casualties of fire. The old buildings burned each year are worth with their contents nearly as much as the new buildings built, and the fires are chiefly due, exclusively due it may be said in their origin, to this inflammable American building material so generally used both on the inside and outside of our buildings. The question then transcends any mere question of taste, and expands to the measure of a question of self-preservation. Can we afford to encourage the use of any building material which is not only esthetically inferior but which may either originate a conflagration or promote its spread?

The ability to make a reform rests mainly in the hands of the architects, and they should begin their attack on wood construction by carrying the outposts. It should be said, indeed, that they may begin by carrying the citadel, for the moment when wood loses its fashionable veneer it will tumble through all the successive stories of architectural construction until it is finally buried out of sight below the foundations. Tile, terra cotta, marbled slate, and even plaster of Paris are all better materials for interior decoration than wood, even on the score of economy. They may not be as cheap as wood, but they are cheap enough to be made more profitable than wood after this material has lost its respectability.

The architects cannot escape responsibility here. A few years ago the rage for iron building threatened to upset all the canons of architectural design in the United States, and we have still standing many melancholy examples of the hideous possibilities of this material. But the architects were sensible enough to set their faces against the innovation, and the construction of complete iron fronts soon became an exceptional exhibition of bad taste. It can hardly be said now that iron is any longer used except with structural motives, and we have therefore escaped the once threatened disaster.

The architect may be equally influential when he decides that wood must go. His success might not be quite so immediate as his success in the case of iron, because the consideration of greater cheapness will work more strongly in defense of wood than it worked in behalf of iron. Then, again, there will be the traditional ideas of centuries to overcome. It may never be possible to overcome the partiality for wood in the rural districts, so long as it remains the cheapest material. On the prairies where the winds blow the people seem to prefer living in balloons. But it makes but little difference among the farmers. They are trying to make a bonfire of the Constitution for the purpose of burning up their mortgages, and if their wood domiciles take fire in the conflagration it will not be much matter. But as soon as the stigma of professional disapproval has been placed upon the material wood will begin to disappear from our cities, and then we shall escape the double horror of some unsightly buildings and the premature cremation of the occupants.

It would be hard to find another subject so important within the range of architectural discussion. It involves almost every architectural problem in fact. It is a question of taste, of mechanical construction, and of economy in the proprietary tenure of buildings, and from every point of view the argument is so overwhelming against wood that one must wonder that it has been so long regarded as a fit building material.

BUILDING THE CABLE-ROAD IN NEW YORK.

By George Iles.

NEW YORK among American cities presents the chief need for urban rapid transit, not only because she is first in population, but from the peculiarities of her topography. Manhattan Island is narrow, and as the water-fronts of Brooklyn and Jersey City make their closest approach near the southerly shore of the island, the principal business focus of the metropolis must perforce remain near that extremity. As New York can grow only northward, its average resident has year by year had his home removed farther and farther away from his place of business. Had not the engineer come to his aid with the locomotive, his dependence on the horse would have made the animal master rather than servant, and seriously limited the city's expansion. But if the spine of New York is long, its ribs are short, and, as the success of the elevated roads has proved, it is profitable to the carrier and convenient to the passenger that through the city's longitudinal form they are always neighbors.

How strenuous the resistance offered to the occupation of Broadway by a surface railroad is still fresh in the public mind. No sooner, however, had the benefits of the line been demonstrated than the question arose: If good, why not better? Cannot the horse be banished, promoting economy and cleanliness, and incidentally setting free the space he takes up? As a result of prolonged investigation it was decided by the railroad company to adopt cable traction. Coal is a cheaper fuel than oats or hay; a 250 horse-power engine asks much less room and care than 250 horses, with the added advantage that the engine can work every hour of the 24, and, with an occasional day off, be none the worse. However, to construct a cable road is vastly more expensive than to build a horse railroad; and that independent and reversible unit, the horse, can be gainfully displaced by a cable only where the number of passengers is large; or where suburbs can be peopled for the road's behoof by a speed of travel beyond the horse's limit. Since 1886 the Tenth-avenue line has been successfully operated by cable, and with the much larger volume of traffic on Broadway still better results are anticipated.

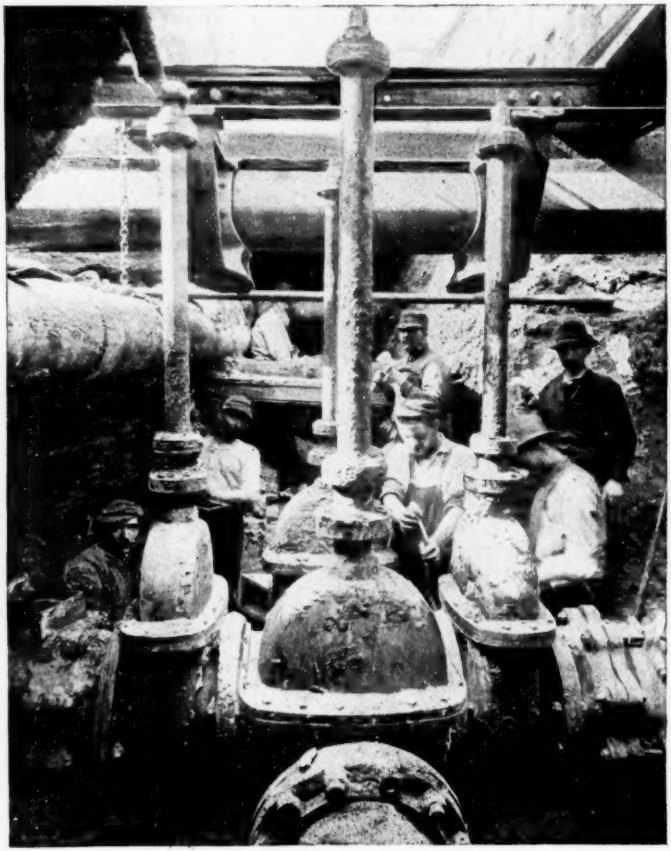
So large a proportion of the total power of a power-station is absorbed in keeping a cable in motion that the efficiency of the driving-plant increases rapidly as the percentage of live load gains upon that of dead load. On Broadway, during the busiest hours of the day, it is proposed to provide a car every forty seconds,—that is, at intervals of one block and a third,—the speed being six miles an hour; this will allow the engines to exhibit an effectiveness unapproached on any other cable system. It was needful that the project should show exceptional economy in operation, for from the first it was clear that the cost of the road would be enormous. Indeed, until quite recently men of capital would have shrunk from the outlay cheerfully assumed by the constructing company. To-day, thanks to engineering and mechanical advances, extending to every department of production, American dollars are so plentiful that the cost of hiring them was never before so low. Any enterprise, such as this road, commands abundant capital for its installation, where increase of first cost means a net saving through diminished expenses for maintenance and operation. The modern subscriber to an engineering scheme is convinced that the way to earn the largest dividend is by liberality of original outlay in providing, as in this case, the most substantial construction and equipment.

The engineers engaged by the Broadway and Seventh-avenue Railroad Company to transform its line into a cable-road had for their preliminary task a survey of the ground beneath the street, so as to ascertain what obstructions stood in the way. It was soon evident that the work would afford a capital opportunity to give Broadway the long-proposed tunnel to contain its drain-pipes, its mains for water and light, for pneumatic and electrical communication. The construction of such a tunnel was very thoroughly considered, and, in fact, the project had at one time advanced so far that detail drawings were prepared, estimates of cost were received, and the contract was once on the point of being let. The plans contemplated a metal structure which in case of subsequent excavation would support the cable track,—forming, practically, a subterranean elevated road. Indeed, the whole detail, not only of the structure itself, but of the plant by which it was to have been constructed and the methods of accommodating street traffic meanwhile, were carefully worked out, and many ingenious devices were planned to overcome obstacles at first view insurmountable. Among other projects, it may be mentioned that in the long

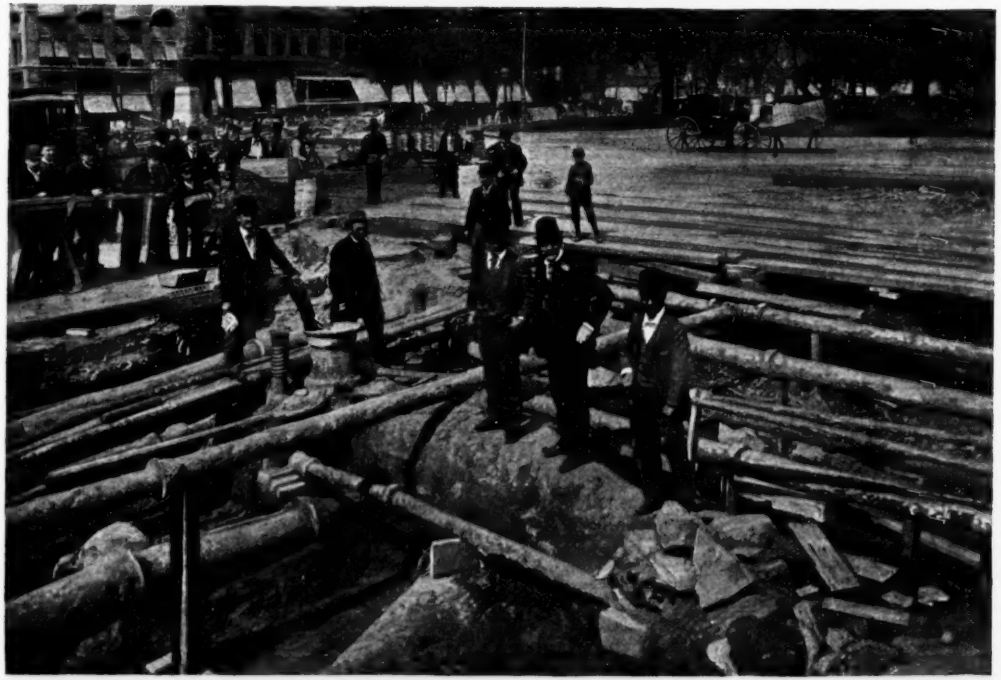
BUILDING THE CABLE-ROAD IN NEW YORK—UNDERGROUND BROADWAY.

stretches of sandy soil the supporting columns were to have been sunk by water-jets; their level reached, a thin grout was to have been substituted for the water so as to solidify the sand around the columns and increase their supporting power. A similar process was to have solidified the sand between the columns in the siderows so as to form it into a retaining wall; for this purpose pipes were to have been inserted temporarily and withdrawn before the injected cement should have had time to set.

In the tunnel so formed it was proposed to run express trains,



STEAM-HEATING MAINS AND VALVES IN BROADWAY.

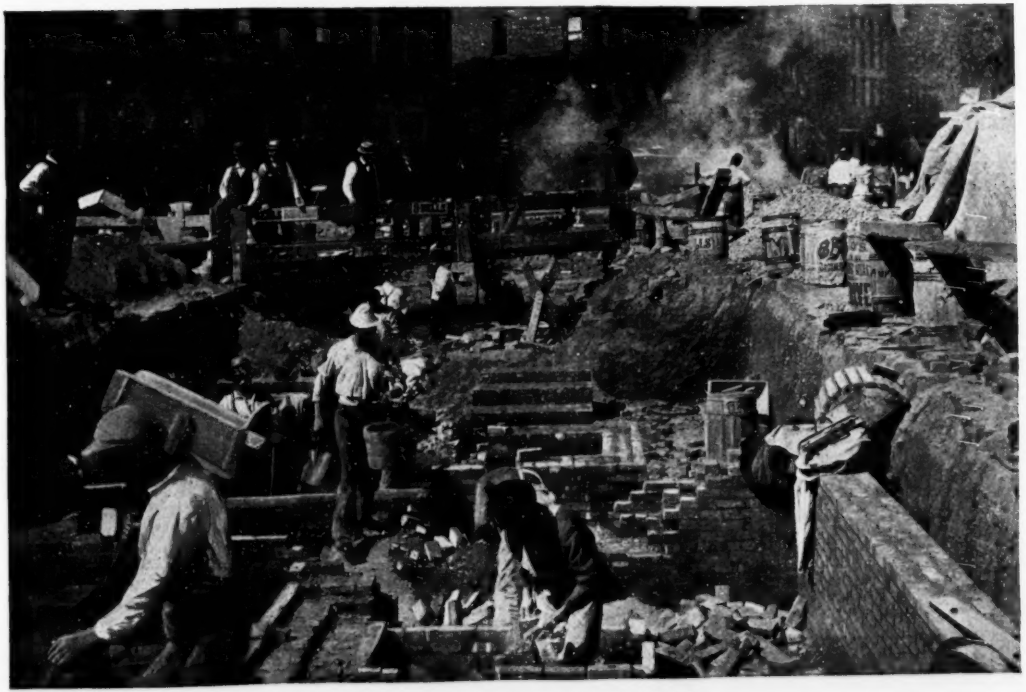


UNDERGROUND PIPES IN BROADWAY, SOUTH OF UNION SQUARE.

also by cable, at a much higher speed than would be practicable on the surface. The improved means of transit thus planned was to be cheap as well as rapid. By a system of transfer-tickets it was intended that a passenger could take a surface car to the nearest express station, thence an express train to the station closest to his point of destination, and finish his journey on the surface car again, all for one fare. However, as the difficulties of the undertaking developed themselves, the estimated cost was found to be prohibitory. To rearrange underground Broadway means much similar

EXCAVATION IN BROADWAY, ABOVE THIRTY-SIXTH STREET.

work at every intersecting street, and the price will not be paid until New York values as highly as London and Paris the advantages of giving to a main thoroughfare an orderly arterial system, easy to keep in repair, always ready for the addition of new services, and at its surface free once and forever from upheaval. The illustrations which accompany this paper show the medley exposed on portions of Broadway, where for almost the whole width of the thoroughfare pipes, wires, and conduits lay side by side, many of them within three to six inches of the pavement. Each pipe, tube,



BRICKLAYING IN BROADWAY, OPPOSITE UNION SQUARE.

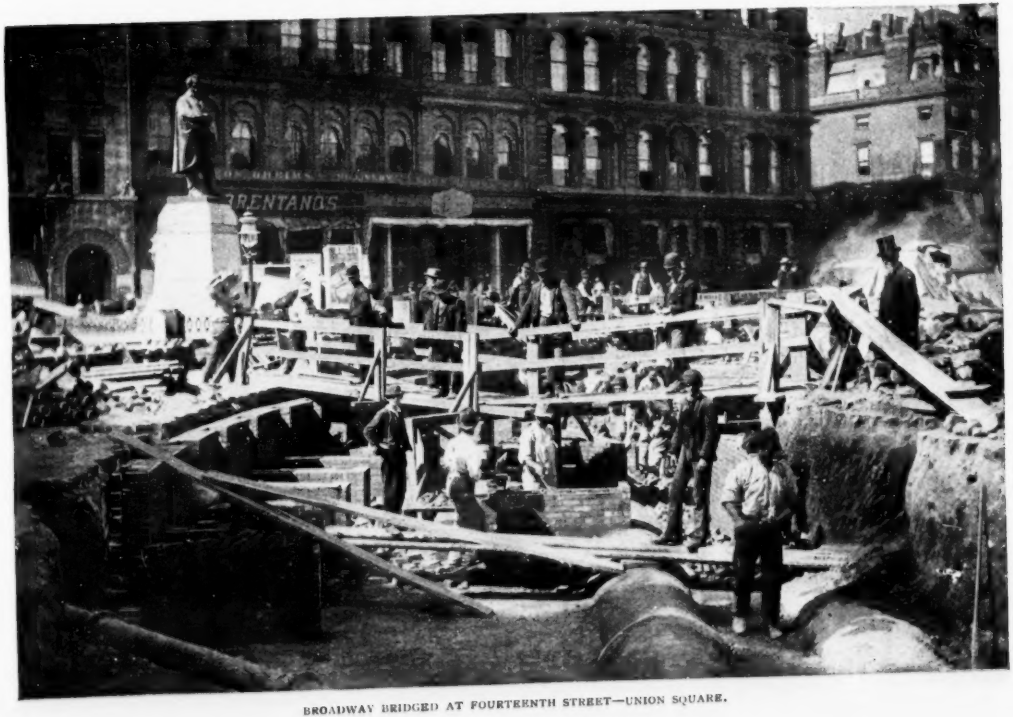
and conduit, as pick and shovel unearthed it, seemed to have been laid with little or no regard to any other, and usually in the cheapest possible fashion. Of the mains the largest were those of the Croton water system; then came the pipes of the five gas companies which enjoy the freedom of any New York street; close by were the tubes of the telegraph and electric-light companies, and the cables of telephone wires. Below all these ran the sewer-mains and the pipes of a steam-heating company.

To accommodate its double tracks the excavation for the road, prosecuted as a surface line, had to be fifteen feet wide by three feet deep, so that it became imperative to relay many miles of mains and piping. To minimize the need for upturning the new pavement in the near future, hundreds of new branches and connections were laid throughout the course of the road. The pneumatic tubes of the Western Union Telegraph Company were replaced anew, and the mains of the steam-heating company, with a few exceptions, banished to adjacent streets.

Obstructions natural as well as artificial confronted the engineers when they turned their faces northward. At and above Thirty-fourth street the original rock formation of Manhattan Island came to view; this was attacked by steam-drills and blasted with 5-pound charges of powder, shields of 12-inch timber insuring the safety of the passers-by. An illustration which accompanies this paper represents the scene of attack just above Thirty-sixth street, which might well be imagined to be the shaft of a mine instead of an excavation in the heart of a great city.

To reduce to a minimum the interruption to traffic on Broadway severely taxed the resources of the engineers. The work was prosecuted both day and night, Welles lights being employed at night. Portable foot-bridges spanning the excavations carried pedestrians; the street-car tracks were removed a few rods at a time and relaid near the curb with temporary turnouts. Begun May 18, 1891, the roadway proper was practically completed in November, 1891, and could have been finished much sooner but for the task of bringing underground Broadway from chaos to order.

The termini of the line at South Ferry and at Fifty-ninth street are about five miles apart. At intervals of 31½ feet the excavation has been deepened for man-holes, which are also carrier-pits, to four feet. For each iron yoke to support the track, concrete foundations were laid 45 inches long, 18 wide, and 6 deep. Most of the concrete was mixed on the spot by a Cockburn machine, which re-



BROADWAY BRIDGED AT FOURTEENTH STREET—UNION SQUARE.

ceived stone, sand, cement, and water at one end, and discharged concrete at the other. Two grades of concrete were employed: coarse, for the lower portions of the foundation, consisting of one part cement (chiefly Portland), four parts sand, and six of 1½ inch stone; for the upper portions a finer quality was prepared,—one part cement, three parts sand, and five of stone between ¾ and 1¼ inches. The mixer, boiler, and engine were mounted on a stout track which followed up the work.

The concrete foundations for the yokes upon which the rails are fastened rise to within thirty inches of grade; at intervals of 31 feet 6 inches carrier-pits for the cable-pulleys are sunk, each 42 inches long, 37 wide, and 48 deep. The yokes have an extreme height of 37½ inches and weigh 550 pounds. They are spaced 4 feet 6 inches apart, except at points where unusual obstructions exist. These yokes have more than double the strength of those used for the comparatively light traffic of Western cities. Connecting them together, and forming the cable conduit between them, is a $\frac{3}{16}$-inch steel plate curved to a contour resembling that of an inverted horse-shoe; to secure drainage for rain- and snow-water, the conduit, at every carrier-pit, is connected with the sewer-mains. Surmounting the conduit are the slot-rails of Z-section, seven inches in height, and weighing 67 pounds per yard; the slot for the grip-shank is ¾ of an inch in width. As the conduit has the unavoidable disadvantage of being an arch without a keystone, special pains have been taken to reinforce it; a 6-inch course of concrete surrounds it, which is carried up to support the paving blocks. These blocks, of Maine granite, laid by the company under its contract with the city, let it be said parenthetically, exhibit the best example in the United States of paving for heavy traffic. The steel rails proper are of grooved-girder pattern, and weigh 91 pounds to the yard; they are laid at standard gage. Above Thirty-fourth street the track centers are 10 feet ½ inch apart; below Thirty-fourth street this distance contracts to 9 feet ½ inch. In the iron construction of the road the only special tool employed was the hydraulic rail-punch mounted on a track.

For operation the road is divided into four sections: the first runs a short distance,—about a quarter of a mile, from South Ferry to Bowling Green, with a single cable; the second section extends up to Houston street, some two miles; the third from Houston to Thirty seventh street, about 1¾ miles; the fourth to Central Park at Seventh avenue and Fifty-ninth street, about one

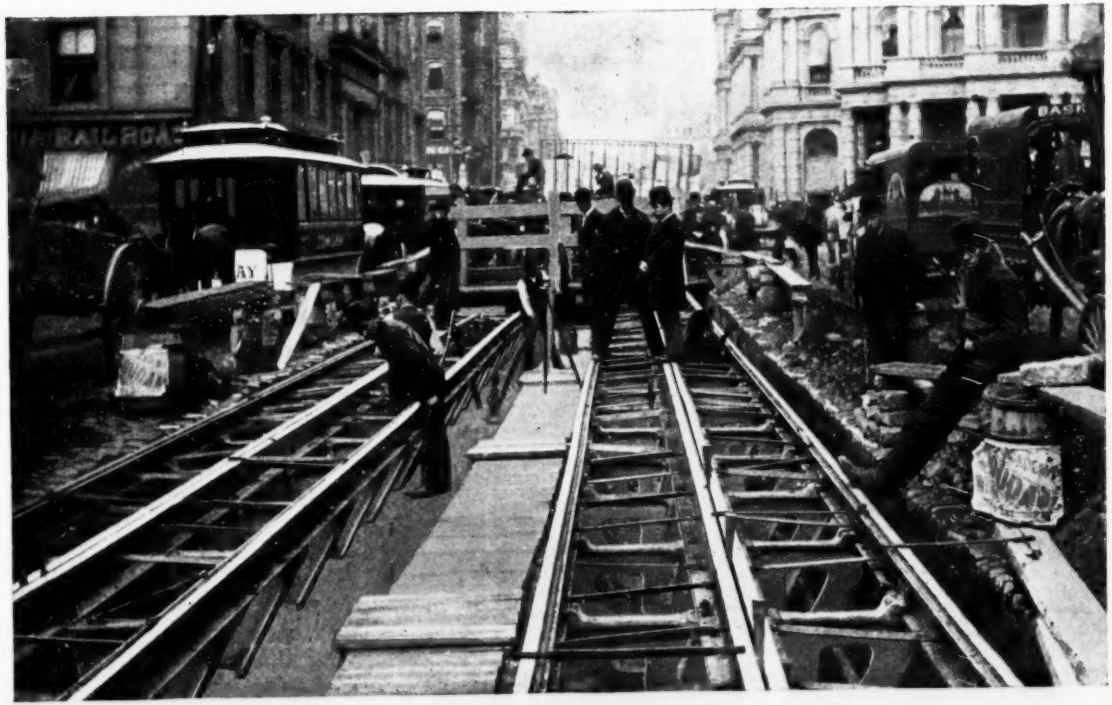
FASTENING RAILS TO YOKES—LOOKING NORTH FROM CANAL STREET.

mile. In all the sections but the first, which is very short, two cables are laid in the conduit; in case of need the cable at rest can be quickly set in motion and clutched by the car-grip. As a resource in accidental and other emergencies this duplication has been extended at the power-stations to the engines, cable-drums, and tension-runs. In view of a strain which may average as much as 12,000 pounds the cables are of the unusual diameter of $1\frac{1}{2}$ inches; their six strands, each of nineteen wires of mild crucible steel, are wrapped around a hempen core to insure flexibility. The steel has a high tensile as well as torsional strength, and is capable of showing a good percentage of elongation. The grips are of the duplex, side-opening type, which has approved itself in competition with a variety of other patterns. The cars, built by the John Stephenson Company, will measure twenty-two feet in length by seven feet in

THE NEW BROADWAY CARS.

width; they are to be equipped with safety fenders. Their framework will be in oak, the walls and seats in ash and maple.

The principal power-station, of which the architects are McKim, Mead & White, is at Broadway and Houston street. As its upper stories are to be occupied for warerooms and offices, it has been necessary to isolate the floors from the vibration of the driving-plant. Adopting the principles of observatory construction, the foundations for the boilers, engines, and machinery are wholly unconnected with the foundations proper of the building. At the rear of the sub-basement, which lies $38\frac{1}{2}$ feet below the street-level, are ranged twelve Heine patent safety-boilers, each of 250 horse-power, having a working pressure of 100 pounds. It is estimated that half these boilers will give steam enough for an ordinary day's traffic, leaving an ample reserve for cleaning and repairs as also for the extra work to be done in muddy and snowy weather,



FINISHING IRONWORK OPPOSITE POST-OFFICE.

[The traffic of Broadway shunted.]

THE CURVE AT SEVENTEENTH STREET, UPPER END OF UNION SQUARE.

THE LOOP AT BOWLING GREEN, FOOT OF BROADWAY.

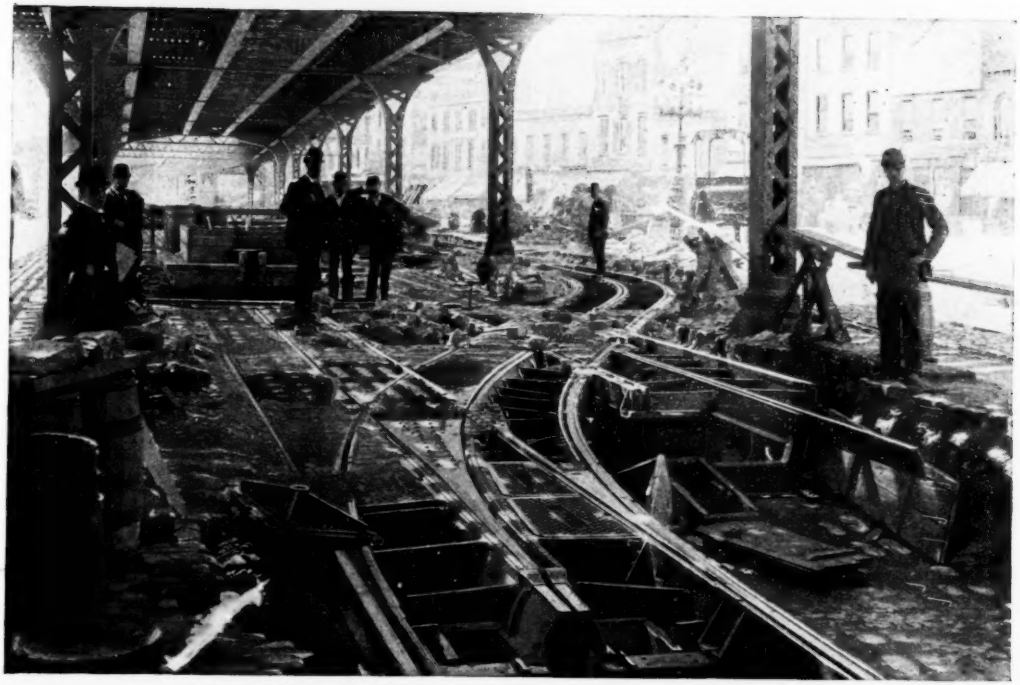
or to meet the demands of holiday transportation. The four engines are of the Corliss pattern, of the simple condensing type, condensing water having been reached by six tube-wells driven eighty-six feet below the street level. To reduce the noise and vibration of the machinery, cotton ropes are used instead of gearing for driving the intermediate jack-shaft and the shafts of the cable-drums. It is expected that by December 15 this station will be in working order; the station at Fifty-first street, being much less extensive and elaborate, probably will be completed a fortnight earlier. The third station, erected at Front street, to operate the cable between South Ferry and Bowling Green, will be finished during the winter.

By January 1 the upper part of the line is likely to be operated. That the method of propulsion throughout the road may be changed to electricity is quite within the possibilities. Its conduit could be readily adapted thereto on the appearance of a practical and economical conduit system. The current surmise that the road is to be extended northward, so as to form a suburban line, is in part based on the fact that the power station at Fifty-first street is near the present upper terminus of the road and might easily be enlarged to serve a long stretch of line beyond it.

In design, in construction, in the difficulties overcome in its prosecution, this cable road through Broadway is a credit alike to its engineers, its builder, and to New York. The builder of the road proper was John D. Crimmins, one of New York's best known contractors, and to his energy and enterprise are largely due the rapid prosecution of the work, both in clearing the way and in building the structure, so that, in barely six months, ten miles of carefully-designed cable work were laid through the busiest street of the new world, through all the obstructions that the needs of a great city had placed beneath it in two centuries of growth. Mr. Crimmins is now the president of the Houston, West-street and Pavonia Ferry Railroad Company, (practically the Metropolitan Traction Company,) which has leased a number of other street-railroad lines, of which the Broadway road is one. Before Mr. Crimmins's accession to this position, Mr. Henry Thompson, then president of the Broadway road, was the executive officer of the railroad company and efficiently performed the difficult task of organizing the work and getting it fairly under way.

Both the design of the road and its construction have been

THIRD-AVENUE CABLE-ROAD UNDERGROUND WORK AT ROOSEVELT STREET.



THIRD-AVENUE CABLE-ROAD—SWITCH AT SEVENTH STREET.

under the direction of Major G. W. McNulty, the engineer-in-chief. His assistants have been H. W. Brinckerhoff, in general charge of the office; N. S. Latham; Albert Carr; A. N. Connett, now chief engineer of the cable-road of the Baltimore City Passenger Railroad Company; and G. F. Simpson, recently chief engineer of the Harriman (Tenn.) Coal and Iron Railroad Company; all in charge of divisions: M. W. Sewall, in charge of design of power-stations and cable-plants; and C. I. Earll, in charge of design of track-work, including grip and curve mechanism. The architects of the Houston street power-station have already been mentioned. W. B. Powell, of Philadelphia, has had charge, as architect, of the work of remodeling the building on Fifty-first street to suit the requirements of a power-station. William Shickel is the architect of the Front street station.

The material, both for the roadway and the cable-plants, was furnished by the Pennsylvania Iron Works Company, of Philadelphia, as general contractors, and much of the work was made at their shops. The Dickson Manufacturing Company, of Scranton, supplied, in addition to the engines, a large quantity of other driving plant; the remainder, including the large rope-wheels and the friction clutches, came from the Walker Manufacturing Company, of Cleveland.

Another piece of cable-road construction in New York, now fast approaching completion, will give Third avenue, from City Hall to One-hundred-and-thirtieth street, cable traction by May 1, 1893. The Third Avenue Railroad Company operates the cable lines which traverse One-hundred-and-twenty-fifth street, and which run through Tenth avenue to One-hundred-and-eighty-sixth street; a single fare carrying a passenger over both lines. As a farther stimulus to the expansion of its suburban traffic, the Third Avenue line, above Sixth street, according to its charter, will be able to offer the speed of 9 miles an hour. The uptown power-station is at Third avenue and Sixty fifth street; it will contain four engines, each of 1500 horse power; the down town station, at Bayard street and the Bowery, will have two similar engines. Both stations are being built and equipped in the most substantial fashion.

Rumor has it that the metropolis will soon have cable-systems in certain other of its leading thoroughfares. Sixth avenue and Lexington avenue are mentioned as likely to be traversed by cable lines in the near future.

INDUSTRIAL DEVELOPMENT OF THE SOUTH.

By Richard H. Edmonds.

III.—TYPES OF RECENT PROGRESS.

THE destruction wrought by the civil war, and added to by political troubles and by the control of the State governments by an ignorant and corrupt element, resulted in making the South not only poorer in 1870 than when the war ended in 1865, but still poorer in 1880 than in 1870. In previous articles the writer has pointed out the tremendous losses incurred by the South on account of the war, how the assessed value of its property was less in 1870 than in 1880 by over $2,000,000,000 and how its aggregate war loss was more than $5,000,000,000, or eight times as much as the combined capital of all the national banks now in the United States. The ten years from 1870 to 1880 showed a continued decline, augmented by the great panic of 1873, so that in 1880, according to the assessed value of property, the South was poorer than in 1870 by $300,000,000. With the country at large increasing with amazing rapidity in wealth and population, the year 1880 opened with the South just beginning to emerge from the continually increasing poverty of the two preceding decades. Its aggregate wealth was scarcely equal to the *increase* in its wealth between 1850 and 1860. Such was the condition of the South about 1879 and 1880. The long night of political debauchery and misrule had ended a few years before, and the people of that section as well as the people of the North regained confidence when the last of the Southern States passed from the rule of the carpet-bagger into the control of the better elements of the native population. With confidence restored the work of upbuilding commenced.

To appreciate the marvelous record of the last ten years the reader must contrast the South of 1880 with the condition of the country at large. On one side the poverty already depicted, on the other a degree of progress and prosperity which up to that time had never been surpassed. The opening up of the virgin fields of the great West and the construction of gigantic railroad systems with government aid served to draw millions of foreigners to that section, and thus there was created the most profitable field that the world had ever seen for the surplus capital

and energy of the East and a market for the products of all its factories. Then came the enormous grain crops of 1879 and the years following, and a European demand which taxed our ability to meet it, burdened our eastern and western railroads with traffic, crowded our ports with the ships of all nations, and started the great boom of 1879 and 1880. What a contrast! The South just struggling to get started—the North and West thrilled with the "music of progress, the whirr of the spindle, the buzz of the saw, the roar of the furnace, and the throb of the locomotive." In the struggle for industrial supremacy, for the development of its cotton-manufacturing interests against the antagonism of New England mills, for the revival of its long-dormant iron business, in the face of the bitter opposition of the strongly intrenched iron interests of Pennsylvania, which never permitted an opportunity to pass to decry the possibility of the South becoming an iron-producer,—in all this hard fight, how has the South acquitted itself? If it has developed its cotton and iron manufactures, increased its agricultural productions, and grown in wealth with anything like the rapidity of the North and West, it has demonstrated that it has superior natural advantages and that its people are not wanting in energy and brains when weighed in the balance against their competitors in other sections. What shall be said of the South, if it be proved that, notwithstanding its poverty in 1880 as contrasted with the wealth and power of other sections, it has advanced in industry and agriculture faster than they?

As Birmingham led the way and for several years stood almost alone as the representative of the new era of progress in the South which 1879 and 1880 ushered in, its history merits a brief review. As early as 1870 several gentlemen living in Alabama, knowing that two railroads were to cross at or near Elyton in Jefferson county, where there were immense deposits of coal and iron, formed a corporation for the purpose of building a town at that point. The capital stock of the company was $200,000, half of which was paid in. The work of development commenced early in 1871, and the town grew so rapidly that in February, 1873, it had a population of about 4000. Such progress—a growth of population from nothing to 4000 in two years—would be considered remarkable even in these days of booming towns. But the panic of 1873 had an extremely depressing effect upon the whole South, and before Birmingham could rally from it there came a serious epidemic of cholera which almost depopulated the town. For several years there-

after it looked like a deserted village with many unoccupied houses, and there were no signs of any revival. The land company had a hard struggle to live. Its indebtedness steadily increased until, in 1875, it was about $75,000. One creditor had a claim for $18,000 which the company offered to pay in stock at $50 a share, but he refused this settlement. If he had accepted this stock, held it for ten years, and then sold at the market price, he would have realized $1,722,000. In 1879 the company donated a site to two Southern men, Messrs. Hillman and DeBardeleben, for an iron furnace, and in the spring of 1880 work was commenced on Alice Furnace No. 1. With the building of this furnace Birmingham began to show signs of new life. The construction of large rolling-mills and furnaces rapidly followed, and within three years Birmingham had opened to the South a pathway to a greater prosperity than it had ever known, though it will yet be some years before that condition is reached. In 1886 and 1887 the wonderful boom which directed the world's attention to the industrial possibilities of the South was in full force at Birmingham, and the Elyton Land Company became one of the most successful enterprises that this country has ever seen. In 1887 it paid 2305 per cent., or $4,610,000 on $200,000 capital, though the real percentage on the cash invested, $100,000, was over 4600. Besides, large sums were expended on the permanent improvement of its property. Its stock, which at one time was as low as $15 a share, rose to $4500. Many land companies organized since have used the success of this company to induce the public to believe that their stock might experience just such an advance. Unfortunately most of the companies that have done this have been the ones whose stock will be the last to advance, because most of them have been heavily capitalized, badly managed, and based upon town sites the conditions of which would make impossible a duplication of Birmingham's progress. Some other Southern land companies may duplicate the Elyton company's success, and some Southern towns may equal the amazing growth of Birmingham, but it cannot be expected that there will be many such. It is true that the stock of the land company which started Roanoke, Virginia, only ten years ago is now quoted at $2500 with $10 as par, and that it has paid dividends of 1750 per cent. in a single year.

The growth of Birmingham and the success in iron-making there aroused the whole South by showing possibilities which had not been fully appreciated before. New towns were started,

furnaces built, hundreds of enterprises projected,—some good and some bad,—and then there came a real-estate or town-lot speculative fever, which, sweeping over Alabama, passed into Tennessee, and thence to Virginia. As in all great speculative movements the line of safety was passed, and for a time there was a wild craze which seemed likely to do the South great harm. Hundreds of shrewd operators from the North and West went South. Some were honest and some dishonest. They projected new towns almost without number, and played upon the speculative excitement successfully enough to sell many thousands of dollars of lots at places where towns of any size can never exist. Some Southern people engaged in the same work. During this fever of excitement the Baring failure startled the financial world, and many projected town enterprises collapsed. Many that failed had been honestly projected, but in such a sweeping disaster the good as well as the bad must suffer. The subsidence of the boom was made an excuse by many enemies of the South to say that the progress of that section was all fictitious, that it had no such advantages as its friends claimed, and that the panic would suspend development for years to come. On the contrary, the panic has had a salutary effect. It repressed the fever of speculation which at one time threatened to prove injurious to the best interests of the South. It caused a more careful study of the small economies of manufacturing, which has resulted in putting industrial interests on a more solid basis. This is illustrated by the fact that the Tennessee Coal, Iron, and Railroad Company, one of the largest iron corporations in the country, reduced its cost of producing iron $2 a ton, and made more money last year, despite the depression in iron, than in any preceding year.

The weakest point in a country's financial condition is reached when speculation is rampant and schemes of all kinds, good and bad, are being launched upon the public. It was at just such a time as this that the world-wide financial collapse came upon the South. Add to this the fact that cotton reached the lowest average price in the history of its production, and that iron was in the same condition, and almost universal bankruptcy might reasonably have been looked for in the South. Instead of bankruptcy, failures were very rare, and especially of large enterprises or of financial institutions. The South stood the strain better even than the rich New England and Middle States. Its industrial enterprises kept right on; its furnaces increased their output of iron; its cotton-mills crowded their ma-

chinery to its limit and steadily added new equipment, all the time earning large profits; its banks paid regular dividends; and its railroads prospered, except those which had already been ruined by Wall-street manipulation. It was a trying period, but it proved the soundness of Southern advancement and the ability of Southern men to meet such an ordeal. The effect will be that with the return of confidence to the financial centers of Europe and America the South will stand higher in the estimation of conservative capitalists than before or during the period of the "boom." Then money will go into the South more freely than ever, and industrial advancement will receive a new impetus.

The results which the South has accomplished since 1880—and mainly since 1886—can probably be best impressed upon those who have not studied its growth by some facts about a few of the many towns that have become important industrial centers. The rise of Birmingham has already been touched on, but a few more facts may be of interest. Where the little village of only two or three thousand people stood in 1880, there is now a city with a population, including the suburbs, of about 50,000. The site of one of the suburban towns—Bessemer—was a forest in 1886; now there are at that point seven iron furnaces in operation, a large rolling-mill, and other industries, which in the aggregate furnish more tons of freight to the railroads than does the whole cotton crop of the South. In and around the struggling village of twelve years ago there are now thirty furnaces with a daily capacity of nearly 3000 tons of pig iron, and hundreds of other enterprises, large and small. The record of the city and of every enterprise there shows that Southern men and Southern money have been mainly responsible for Birmingham's growth. The adaptability of Southern people in being able to take hold of manufactures is illustrated in the case of the president of one of the Birmingham iron and coal companies,—a $6,000,000 concern,—which is but one case out of many thousands. Called to the management of this great company a few years ago, when its affairs were in a very critical condition, he accepted the task, though entirely ignorant of iron or iron-making. He has brought this company to the front rank, placed it on a solid footing, made it earn money through all the severe depression in iron, and was spoken of to the writer some time ago by a Northern iron-master as "the best posted iron-maker in the South." He is a type of the Southern men who have made Birmingham, Atlanta, Richmond, Norfolk, Lynchburg, and many other places.

Even Birmingham is not a better exponent of the South's advancement than Atlanta. Pointed out in 1845 by John C. Calhoun as a place so located that the topography of the country would compel railroads to cross "at a point in DeKalb county, in the State of Georgia, called Atlanta, not far from Decatur," the "Gate City of the South" had already won its title before the war commenced. In 1860 it had a population of about 12,000, but when it was captured by Sherman in 1864 the population was exiled and the entire city burned except six hundred houses. With the return of peace the people took up the work of rebuilding their city. Atlanta has no coal or iron on which to build; it is simply a well-located city with a population very largely composed of Southern people inspired with unbounded confidence in the future of the place and working with tireless energy, not only in the prosecution of their individual business interests, but for everything that tends to the upbuilding of the city. Its growth is a type of the growth of the whole South,—a well-rounded development covering every branch of trade and manufactures. In 1880 Atlanta's population was 37,000; the assessed value of its property was $12,000,000; it had 196 manufacturing establishments with a capital of $2,400,000, employing 3600 hands and producing $4,800,000 worth of goods. In 1892 the local reports claim a population of about 100,000; assessed value of property $34,500,000, and the number of manufacturing establishments 630, with capital of $16,000,000, employing 15,000 hands, and producing $33,000,000 worth of goods. Included in these manufacturing statistics are the factories in the suburbs.

It could hardly have been expected that Richmond would recover from the effects of the war as rapidly as some other Southern cities, but its growth, while somewhat less marked than Atlanta's, will compare very favorably with that of probably any city of equal size in New England or the Middle States, notwithstanding their exemption from the ravages of war. The advancement of Richmond in wealth and population has been rapid; its industrial interests have increased enormously, its volume of trade is annually growing, its great tobacco factories are employing many thousands of hands and creating vast wealth, its million-dollar locomotive- and engine-works are building many of the finest locomotives on Southern railroads. These works were able to secure, against all competition, the contract for building the immense engines for the United States war-ship *Texas*. Richmond's growth, which, like

Atlanta's, goes on steadily and solidly, regardless of booms or panics, shows how the whole South is advancing and how wealth and population are increasing even though the world may hear little of what is being done.

In June, 1882, the Shenandoah Valley railroad met the Norfolk and Western at a point then known as Big Lick, which had a population of between 400 and 600. Big Lick gave way to Roanoke, and ten years have seen its population grow to between 20,000 and 25,000, the registered vote being over 5000, which on the general average for the country would mean more than 25,000 inhabitants. The wages paid out to its workmen reach $4,000,000 a year; its banks have a capital of $2,000,000; its building associations, $3,000,000; its factories, $8,000,000; and its land companies, $11,000,000. Its original land company, even in the dull times of 1891, paid 1750 per cent. in dividends, and $3000 a share was bid for its $10 stock. Though speculation throughout that entire section was rampant when the Baring failure came, Roanoke has passed through the crisis without a single failure of importance except of one dry-goods house, and that was not in any way due to real-estate operations.

About ten years ago Mr. C. P. Huntington, then the owner of the Chesapeake and Ohio railroad, decided that a good terminus for that road would be at a point on Hampton Roads known as Newport News. He built a grain-elevator, coal piers, and some wharves, and gradually turned a fair amount of shipping business there. Three or four years ago he concluded to crown his business life with the construction of the finest ship-yard in the world, which should help to regain the prestige of the American marine. Now the largest dry-dock on the Atlantic coast, and a ship-yard which is claimed to be the best equipped in the world, are in joint operation. Nearly $5,000,000 have been expended upon them, and the 1500 mechanics now employed are to be increased, it is stated, to 5000. From the place which was a barren shore but a few years ago the four largest steamships ever built in America, excepting war vessels, have lately been launched, and five regular lines of ocean steamers sail for European ports carrying grain, cattle, and provisions, while nearly 1,000,000 tons of coal are annually shipped to New England ports. Water-works which cost $1,000,000 have taken the place of private wells, and 8000 or 10,000 people live where but one or two thousand lived five years ago.

In 1888 Bell county, Kentucky, was a wilderness. Murder was

the chief occupation of its lawless people; there was not, I believe, a school or church in the county; the mountain people were constantly waging war in their bitter feuds; industrial development was undreamed of. Alexander A. Arthur saw that there were great mineral and timber resources there, that could be reached by a railroad by means of a tunnel under the old Cumberland Gap trail which Daniel Boone followed. He induced English capitalists to buy 100,000 acres of land there, and then formed a town-building company. In the summer of 1889 the whole valley where Middlesborough now stands had fifty inhabitants; on one side the nearest railroad station was Knoxville, sixty miles away, and on the other the Louisville and Nashville passed within forty-seven miles. A railroad was built to Knoxville, the Louisville and Nashville was brought in, the mountain was tunneled, a town was laid out, gigantic enterprises were undertaken,—which, but for the panic which made it impossible for the English stockholders to furnish the money as rapidly as promised, doubtless would all have been completed before this,—and a splendid hotel, elegant residences, and costly business blocks were constructed. The work delayed by the panic has been resumed, and a $2,000,000 furnace and steel-plant to employ over 2000 hands is nearly completed. The great foundry and machine-works of the South Boston Iron Works are being moved there from New England, and will employ 500 to 1000 hands. Thus civilization has been firmly planted where there was only a wilderness three years ago.

These are but types of the progress which has marked the South. The brief details of their growth have been given to show that the advancement of the South has not been confined either to the old towns or to the new ones, but that both are sharing equally in the progress which is bringing prosperity once more to this section. The growth of the towns and cities named has not been more remarkable than that of Louisville, Chattanooga, Knoxville, Winston-Salem, Charleston, Norfolk, Savannah, Dallas, Fort Worth, San Antonio, and dozens of other places.

OUR REMAINING HARD-WOOD RESOURCES.

By Charles Mohr.

THE ever-increasing demands upon our timber resources, resulting already in their exhaustion in many sections east of the Mississippi, must soon force upon the public mind the question of forest protection. This question has a bearing not only upon the interests of a large class of our population who are dependent directly upon the timber industry, but upon the general welfare. A century ago forests covered the eastern part of the United States, with but little interruption, from the Atlantic slope to the Mississippi, but they speedily dwindled before the settler's axe as it subjugated the wilderness for the cultivation of the soil. The progress of civilization, and the increasing necessities of a population unprecedented in the rapidity of its growth, had made such a drain upon the resources of the forests that before the advent of the present generation their exhaustion was general in some of the older States. None of the natural resources of the country has been levied upon with a more relentless energy, or subjected to a heavier strain. Capital and labor found a wide field in this inheritance of timber wealth, accumulated during centuries by the silent but ever active forces of nature, ready to be yielded with great facility to whoever claimed it. There was too much promise of speedy returns not to appeal to a ruthless spirit of greed and speculation, having no regard for the needs of the future. Even within the last twenty years the despoliation of our forests has been carried on with an almost feverish activity, as if there would be no end to their resources, and as if we could not soon enough "get rid of our timber." The work of destruction has even exceeded the economic needs of the people, for under the high pressure of competition, stimulated by abundant capital and improvements in mechanical skill, the timber industry has reached the point of overproduction, liable to result in financial and commercial depression.

The value of the products derived from our forests far exceeds that of the exports of all commodities from the United States, including coin and bullion. In 1880, according to the Census reports, this value was $700,000,000. It may safely be assumed that complete returns, could they be had, would show the amount of material

from the forests consumed annually to exceed a thousand millions of dollars. The industries based upon our timber resources, in the value of their products, rank second if not first among the manufacturing interests of this country. The consequences of such gigantic operations are making themselves painfully felt in regions the timber resources of which, in the recollection of many yet living, were regarded as inexhaustible. Such localities are suffering not only from the want of timber, but also from the injuries connected with the diminution of the forest areas below the requirements for the maintenance of favorable climatic conditions. In illustration of this assertion such States as Ohio and Indiana present important facts. According to official statements the forest area in Ohio was reduced from 53 per cent. of the whole area of the State in 1850 to 17 per cent. in 1880, and in Indiana the forest area declined in the same time to 19 per cent., such shrinkage placing these States with the countries of least forest area in Central Europe. The scarcity and deterioration of the hard-wood timber supplying numerous industries in these and the adjoining States in the North have been for some years a matter of grave concern to thos eengaged in them. At the tenth annual convention of the Furniture Manufacturers' Association, held in Cincinnati in 1881, and at the thirteenth meeting of the National Carriage-Builders' Association, in 1885, the complaint was raised that the supplies drawn from the territory named above were becoming scarce, while a good quality of timber was beyond reach. These are certainly significant admonitions from the representatives of important industries, which have to rely on the timber resources of our forests and upon which thousands of families of artisans and laborers are depending for support.

North of the Ohio river the black walnut and white ash can be said to be extinct as far as practical purposes are concerned, and the better qualities of white oak are now wanting. Mr. William Little, a competent judge and one practically interested in the matter of the timber supplies in the Northern States and in Canada, in an address delivered lately before the Chamber of Commerce in Montreal, says of the supplies of the northern hard-wood forests : "The alarming condition is now painfully apparent to the most casual observer who will contrast the character of the timber manufactured at the present time, running largely into the different grades of culls, with the magnificent black walnut, cherry, butternut, chestnut, hickory, bass wood, black and white ash, and oak,

which, when not used for fencing and fuel, were burnt up in the log-heaps of Ontario in Canada, and in New York, Pennsylvania, Ohio, Indiana, Michigan, and Wisconsin, in the United States, only a few years ago, but which, when manufactured, ran largely into the grades of selects and clear lumber." At a still more rapid rate is the destruction of the forests of white pine, and of the spruce and hemlock, going on. On the Atlantic slope the forests of white pine in Pennsylvania have been almost completely stripped of their timber. In New York and the New England States this pine has almost hopelessly disappeared, with the exception of Maine where, under a wise system of protection, the second growth is of great promise and already contributes considerable supplies.

The most extensive and alarming instance of the despoliation of a timber wealth, considered inexhaustible only a few years ago, is presented by the immense pineries of the Northwest, which seem destined in the near future to complete destruction. With their timber wealth in a vast body, made easy of access by improved methods of labor and transportation, and in close connection with the treeless region in the heart of the continent filling up rapidly with an agricultural population, in the States of Michigan, Wisconsin, and Minnesota the lumbering industry has assumed the largest dimensions, causing a drain upon the resources of their forests which will in a short time cease to respond to further demands. The amazing activity with which this industry is carried on in the pine-lumbering regions of these States can be realized from the statement of the *Northwestern Lumberman* [Chicago] that the amount of lumber produced in 1889 reached the aggregate of 8,305,833,277 feet, board measure, to which is to be added the output of shingles in the same period of 4,698,975,800 pieces, swelling the consumption of white pine lumber from that section to fully 9,000,000,000 feet, board measure, in one year. The amount of merchantable white pine standing in lower Michigan, estimated in the Census reports of 1880 at 29,000,000,000 feet, during the subsequent ten years has been reduced to one-tenth of that amount, according to the Chicago *Timberman*. Thus the stock left would just suffice to supply the material for first-class lumber produced in a single year in the white pine forests of the Lake region.

With this increasing scarcity of timber in general and the impending exhaustion of the white pine north of the Ohio river, the lumbering interests of the eastern United States are gravitating towards the south Atlantic region. Scarcely any attempts have

been made to arrive at estimates of the different kinds of hard-wood timber standing. It is known certainly that in the Southern States every variety of hard-wood occurs that is found in the North, besides several other kinds of economic importance, peculiar to the Southern flora, or attaining in lower latitudes their best development. In the alluvial swampy lowlands and in the valleys of the larger streams and their first tributaries, with their bottoms less subject to occasional overflow, are found forests of wide extent unsurpassed in the diversity and quality of their resources of hard-wood, which generally have been encroached upon but little.

Among the States south of the Ohio river, West Virginia takes the first rank in the wealth of its hard-wood forests. Only 25 per cent. of its area has been cleared of them. Nowhere is black walnut now more frequently found ; nowhere is wild cherry, ash, white oak, chestnut oak, or tanbark oak more abundant. It is only in the narrow strip along the larger water-courses that these supplies in this State have been largely removed, and only in the more accessible parts that they have been more or less culled. Large bodies remain untouched in the southern valleys and the lower slopes of the mountains enclosing them. By the Tenth Census it was estimated that 2,500,000,000 feet (board measure) of yellow poplar (tulip tree) timber are yet standing in the valley of Cheat river and its tributaries and 300,000,000 feet on Shaversfork, besides large quantities of the valuable timber trees named, which cannot be driven in the shallow streams and can only be made available by the construction of railroads. On the upper part of the Little Kanawha river and its tributaries there are large supplies of white oak yet untouched ; in fact, all the country back of the counties fronting on the Ohio river is one vast virgin forest of oak, tulip, wild cherry, black walnut, and sugar maple, only touched upon along the largest channels of drainage, being yet for the greater part inaccessible. The development of these resources has made comparatively slow progress, but with the increasing facilities for transportation by rail it is certain to make rapid strides within the next few years. There is but scant information at hand relating to the increase of the industries based upon the timber resources of West Virginia. The output of the sawmills in 1886 amounted to only 4,000,000 feet (board measure), and these were situated chiefly at Parkersburg and Ronceverte.

In the report of the chief of the forestry division of the Department of Agriculture for 1887, the area of Kentucky covered by

forest is stated at 30 or 35 per cent. The white oak is the timber most prevalent and most characteristic of the State. Large tulip trees and most of the valuable hard-woods are found in greater or lesser abundance in the forests of various sections of the State, and in eastern Kentucky and the region of the Cumberland mountains are yet almost untouched. The area of 10,000 square miles between the Louisville and Nashville railroad line and the Ohio river has been pronounced by Professor N. S. Shaler to be one of the richest and at the same most easily accessible hard-wood timber regions in the Ohio valley. In a report by R. C. B. Thruston, made to the president of the Louisville and Nashville railroad in 1887, it was stated that the hard-wood forests of the valleys and the table lands of the Cumberland mountains extend over an area of 4000 square miles, with a stand of timber running from 6000 to 14,000 feet, board measure, to the acre. The manufactories of wagons, carriages, agricultural implements, furniture, and cooperage stock draw largely upon these resources. The 2319 establishments of the State based upon them in 1885 were using material valued at $14,576,014 with products valued at $29,446,339. The lumber produced from oak and tulip trees by 805 sawmills in that year was estimated at $4,889,196. Louisville is looked upon as the best and cheapest hard-wood lumber market in this country, if not in the world.

Tennessee, with 60 per cent. of its area still covered by woodlands, possesses a larger proportion of forests of deciduous leaved trees than any other State. The Commissioner of Agriculture of that State, at the meeting of the Southern Immigration Association in 1884, stated that 16,000,000 acres of forests in Tennessee remained in almost their original condition. The nature of their timber growth differs but little from that of Kentucky. The tulip tree is found in the valleys in greatest perfection, and nowhere in the United States in greater abundance. Portions of the State are unsurpassed in the quality and the vast quantities of white oak and tulip timber which they possess. In Obion county alone there were in 1887 fifty-five sawmills with a daily output of 1,000,000 feet of the latter. Tulip trees from six to seven feet in diameter are not rare; no State has yet a greater quantity of black walnut; excellent hickory abounds; blue and white ash, scarce along the highroads of communication, are yet found in considerable quantities in the remoter districts. In the lowlands along the Mississippi river red gum, pupelo gum, cottonwood, and cypress prevail. Nashville is the rival of Louisville as a hard-wood

timber market. The sawmills in that city in 1887, with an annual capacity of 140,000,000 feet, produced 100,000,000 feet of lumber. The black walnut, cherry, ash, tulip, elm, and maple received in this market amounted to 30,000,000 feet, board measure, and the amount shipped in that year was valued at $80,000,000. The sawmills at Memphis, Tennessee, in 1887, cut 60,000,000 feet of hard-wood timber and the receipts amounted to 24,180,000 feet. The cut at Chattanooga and Knoxville combined reached 57,000,000 feet. The total production of hard-wood timber of Tennessee amounted in that year in the aggregate to 271,000,000 feet.

In the mountainous part of western North Carolina are found virgin forests of the most valuable hard-wood timbers, which have become accessible only during the last few years. The table lands between the Blue ridge and the Smoky mountains, and the basin of the Tennessee river, bear a heavy and diversified hard-wood timber growth so far but little drawn upon. In the Atlantic States further South and in the Gulf region the hard-wood growth is confined chiefly to the higher levels section; with the swamp white oak, red or sweet gum, machernut hickory, tulip, cucumber trees, some white ash, red ash, and Spanish oak, and shellbark hickory, in the lower valleys; and mountain or tanbark oak, chestnut, and post oak on the ridges and tablelands of greatest elevation. Black walnut is found scattered in the districts least difficult of access. In Alabama the hard-wood timber trees are most frequent in the eastern half of the Tennessee valley, in the wide rivers and the intricate valleys which separate the detached outliers of the Cumberland mountains, where tulip trees of fine growth form the larger proportion, with white oak, elm, willow oak, and shellbark hickory. The timber has been largely cut along the railroad lines intersecting these parts of the State, and of late years a number of smaller establishments, manufacturing wagon-stock and cooperage stuff in the rough, have been erected in northern Alabama.

The largest body of hard-wood timber in the Mississippi valley, if not the largest in this country, is found in the perpetually damp lowlands between the Yazoo and Mississippi rivers, the unbroken forest covering over 6000 square miles, unsurpassed in the density of its growth and the great development of the trees which are of economic importance. Here the swamp white oak, the Spanish oak, red oak, sweet or red gum, honey locust, cottonwood, and sassafras are found in the greatest perfection. In the water-covered depressions, forming shallow lakes, the mighty cypress rises in the

fulness of its development above all other monarchs of the forest. The forests of Arkansas on the Mississippi and in the valley of the Saint Francis and White river, with a timber wealth similar in kind and development to that found on the opposite side of the Mississippi, extend over more than 2,000,000 acres. In the valleys of a higher level in the same State vast quantities of the ridge or upland white oak, and considerable quantities of black walnut, are yet found remaining almost intact. In similar situations in northern Louisiana and in the uplands of that State and the adjoining parts of eastern Texas the forests of a mixed growth of evergreen and deciduous leaved trees harbor bodies of fine white oak, magnolias, and white bay, with some of the other hard-wood timber spoken of.

Immense as the supplies of hard-wood in the Southern States must appear, there can be little doubt that their depletion will be effected in a period of time scarcely exceeding in length that which witnessed the disappearance of the similar resources once to be found in the North. The era of industrial development upon which these States have entered of late years, with the consequent increase in their population and wealth, cannot fail to create a local demand for these supplies not less than that called for by the Northern States and by foreign countries. The timber lands in the States south of the Ohio river comprise 211,375,000 acres, or 41 per cent. of the forest area of the United States. The number of saw-mills in that territory has increased a hundred fold since the Census of 1880,—that is, from 6266 to 13,380,—and their product from $32,117,000 to $120,246,000. The number of planing-mills has increased from 251, in 1880, to 1526, in 1892, and their product from $3,405,023 to $9,026,000. The value of all other lumber products during the same period has increased from $11,326,000 to $30,222,000.* The next quarter-century is sure to witness an unprecedented activity in the increase of the industries dependent upon the products of the Southern forests. Furthermore, a large proportion of the areas now covered by the hard-wood forests will be claimed for the cultivation of crops to which they are so highly adapted.

The spontaneous reproduction of the better qualities of hard-wood timber is limited by obstacles that leave no promise for the future. There are difficulties in natural dissemination due to the nature of the seeds of most of the hard-wood timber trees of eco-

* New Orleans *Times Democrat*, September 1, 1892.

nomic value, and to the dangers threatening the existence and healthy development of their offspring in the early stages of growth. Under the shade of the original forest covering the second growth is to a large degree suppressed or remains stunted; in the open their progeny is exposed to the danger of destruction by fire and livestock, of which but the smallest part escapes, and which is also liable to succumb under the struggle for the possession of the soil with competing species of little or no commercial value. To reproduce successfully the more valuable hard-woods the fostering care of man is required; in short, these supplies must be grown. This fact more generally understood, with the comprehension of the heavy and ever-augmenting strain to which in many sections these natural resources are subjected, cannot fail to arouse the intelligent land-owner to energetic efforts in that direction. No other improvement can impart to his possession a more permanent value and insure a more profitable inheritance than the raising of timber on his waste or otherwise unproductive lands, not to speak of the increase of comfort and content resulting from the sheltering cover of the forest in its beneficial influence upon the health and success of his crops.

THE IRRIGATION PROBLEM IN THE WEST.

By H. M. Wilson.

THE subject of irrigation is the most important which now concerns the people of the western United States. The most permanent source of wealth in that section will be found in the development of its agricultural and horticultural possibilities. In the larger part of the western half of this country this development will depend almost solely upon the use which is made of irrigation. There is an abundance of good land, the climate and temperature are most favorable for the cultivation of crops, and water alone is lacking for their successful production. In the eastern States and in northern Europe the difficulties with which agriculturists have to contend are those arising from too little sunshine or a lack of good land, and they find it difficult to appreciate that in any other portion of the world this order of things should be reversed, the land and sunshine being abundant and only water lacking to make their vocation profitable.

In the eastern States there are occasional dry seasons in which the farmer complains that his crops will be ruined if he does not have rain. He takes a watering-pot and sprinkles such plants as are most valuable, while perhaps with a hose or water-barrels he wets more or less of his garden truck. This is irrigation pure and simple. The only difference between this form and that practised in the West is that in the latter region the application of water to the soil or crops becomes a business by itself, and the farmer and the engineer unite in studying out methods whereby water may be applied when wanted, in the easiest and least expensive manner, and above all in obtaining a supply of water wherewith to moisten the crops. When nature must be assisted on a large scale, the watering-pot is insufficient and too expensive, and nature herself is called upon to aid in transporting the water. This is done by means of the action of gravity, and irrigation by natural flow is the result. Ditches are made which lead the water from the source of supply,—be it a well, reservoir, or stream,—and they are so aligned and graded that the water shall flow down through these, and from the main ditches into minor channels, and from these again through plowed or drilled furrows into the cultivated fields.

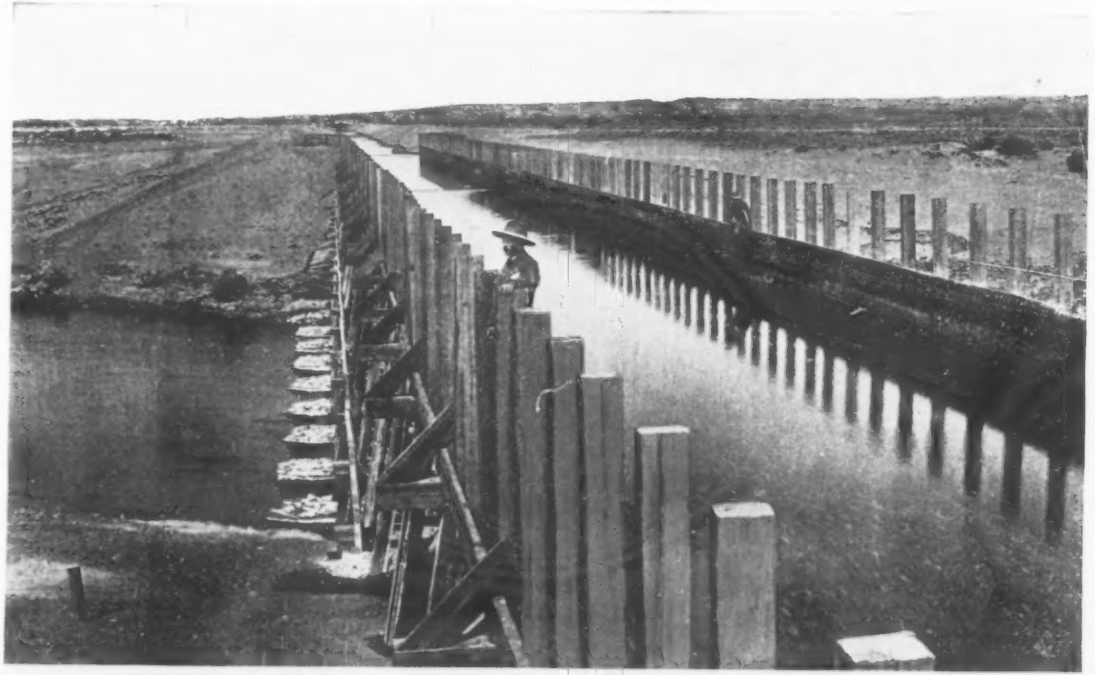
The mistake is too commonly made of regarding the work of irrigation as a hardship and the necessity for it as a misfortune. In point of fact, the necessity for irrigation and the ability to irrigate make a very fortunate combination of circumstances for the agriculturist. The necessity of irrigation implies a warm, dry climate, and this means that the crops are not liable to destruction by sudden violent storms, or by a lack of sufficient sunshine, or by a lack of sufficient water, as might result from dependence upon natural rainfall. The ability to irrigate implies a sufficient water-supply, insuring crops against drought, and it further implies good soil.

For the sake of convenience in writing on the subject of irrigation the lands to be considered with relation to this practice have

THE TURLOCK CANAL, CALIFORNIA—EXCAVATING A DEEP CUT BY THE HYDRAULIC PROCESS.

TURLOCK CANAL—VIEW THROUGH TWO TUNNELS.

been classified as "arid," "humid," and "semi-humid region." The humid region includes nearly all of the country lying east of the 97th meridian, and a small strip along the Pacific coast north of San Francisco and west of the Sacramento valley and Cascade range. The semi-humid region is included in a general way between the 97th and the 101st meridians. The remainder of the West, between the 101st meridian and the Pacific coast, is known as the arid region. These lines as laid down are not hard and fast, but vary during different years, according to the amount of rainfall. Where the precipitation is greater than twenty inches per annum, the region may be classed as humid; with a rate of twelve to twenty inches, it is semi-humid; and when the rate is below twelve inches, the region is arid. Such a division of country according to the amount of mean annual precipitation is an arbitrary one, applicable only to the United States. The true distinction between arid and humid regions is dependent rather upon the amount of pre-

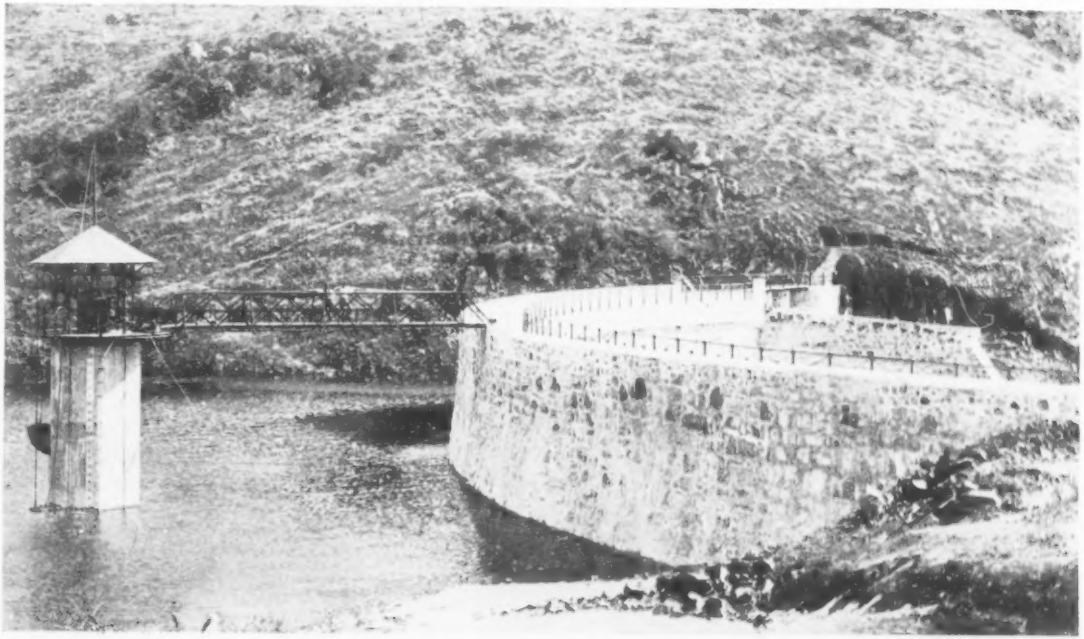


GREAT FLUME ACROSS THE PECOS RIVER AT EDDY, NEW MEXICO.

cipitation during the crop-growing season than upon the mean annual precipitation.

In the humid region in at least one season out of three the farmer gets a short crop, the result of unfortunate climatic conditions, and owing to the degree of habitation much soil that is really unfit for cultivation has to produce crops and sustain life. In the arid region no one attempts to cultivate crops without the aid of irrigation,—that is, without the assurance of an abundant water-supply. There is an abundance of arable land in the arid region, and as a consequence where water is found only the best soil is cultivated. The result is abundant crops every year and, owing to the length of the season, frequently two or more crops in one year. The consequence is a greatly improved condition of the average farmer in the irrigated region. It is in the semi-humid region, however, that the necessity for irrigation is most urgent, though least appreciated. In western Kansas and Nebraska, in Oklahoma, and in western Dakota, there are cycles of from three to five years when the rainfall is abundant. Farmers make their homes there, often buying lands and implements on long credit, and begin the cultivation of the soil. All goes well until the coming of a period of dry years, when the rainfall is insufficient to produce crops, the farmer cannot

CASTLEWOOD DAM, COLORADO, DURING CONSTRUCTION.



DAM AND GATE TOWER, SWEETWATER RESERVOIR, CALIFORNIA.

meet his debts or purchase food, and the result is starvation and poverty, of which the newspapers give us accounts. It is only owing to our excellent transportation facilities, the liberality of our people, and the self-reliant spirit of the American farmer that there is not as great distress in the West as was ever known in the less densely inhabited portions of India. It is in such regions, moreover, that supplying water for irrigation is not a profitable business, for the farmers do not require it except in occasional seasons, when as a consequence no rental or interest is paid on the money invested in

FLUME ON UNCOMPAHGRE CANAL, COLORADO.

the plant. In the arid region the water is in constant use and pays fair returns upon the investment.

In the arid region, where a sufficient settlement seems probable to assure the use of water on a large scale, there has been little hesitancy on the part of farmers or capitalists to construct irrigation works. At first they find it profitable to construct small works, using the waters of the minor streams, since returns from these are apt to be at once realized, because of a sufficient demand for the water. The time has now come when nearly all these minor water-sources have been brought into use, and only the larger and more expensive projects await development. Further development de-

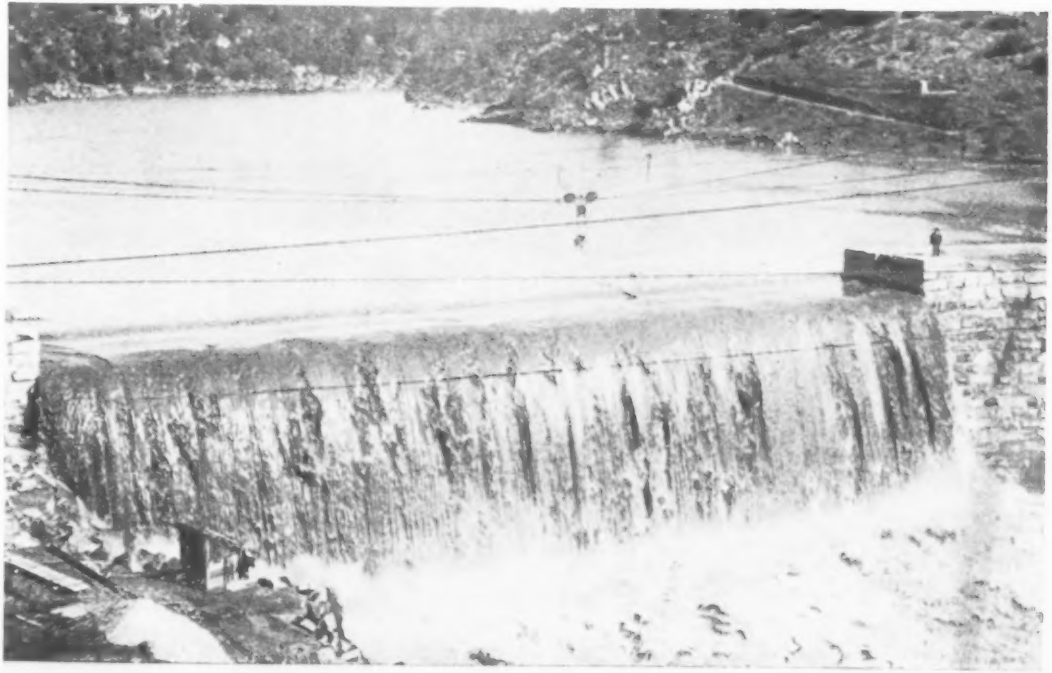
DAM AND WASTEWAY, SWEETWATER RESERVOIR, CALIFORNIA.

pends on immigration and settlement rather than on irrigation. The necessity and possibility of the latter are now well understood and appreciated. Settlement and a demand for the water furnished now mark the limits for further development. This may appear a curious statement, and yet it is true. There is already an abundance of settlement and a large demand for more water, and as water can only be furnished in large quantities and at the expenditure of great sums of money, the few settlers who would at once use it will not pay interest on the works for its procurance. It has been found to be the experience in India and in Italy, as in this

WALNUT GROVE DAM AND RESERVOIR, ARIZONA.

country, that from ten to twenty years after the construction of a great irrigating canal are needed to bring a demand for a sufficient amount of the water to pay profits.

The entire area of the arid region is estimated at about 1,500,000 square miles, or 900,000,000 acres, in extent. The greater portion of this is not arable land,—that is, it would not produce crops even if water were available. Some of it is at such an altitude that the climate is unfavorable, some is sandy or alkaline desert, much of it is steep mountain-side or bare rock. Of the remainder perhaps 100,000,000 acres are arable, but, according to the estimates made by the United States Geological Survey, not over one-



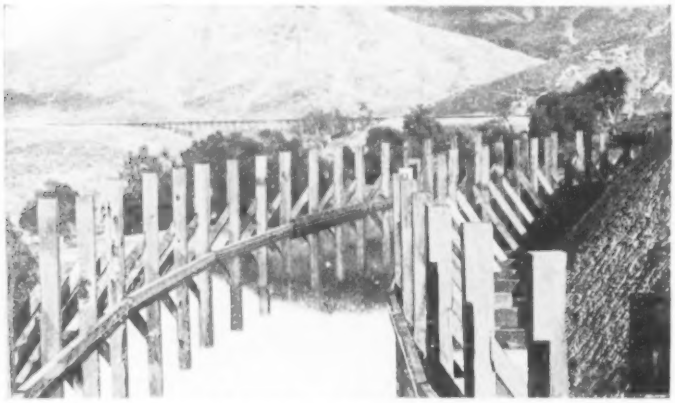
FOLSOM DAM ACROSS AMERICAN RIVER, CALIFORNIA, DURING GREAT FLOOD.

HEAD OF INVERTED SIPHON—PHYLLIS BRANCH CANAL, IDAHO.

WOODEN RAPID OR CHUTE—PHYLLIS BRANCH CANAL, IDAHO.

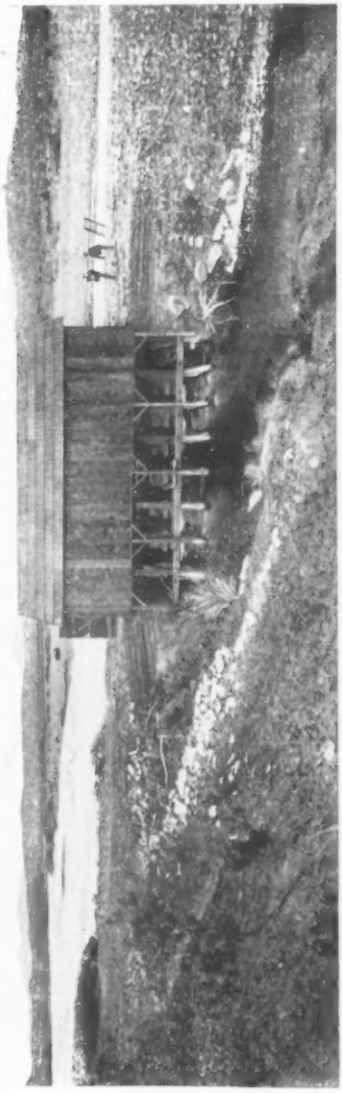
third of this, or 33,000,000 acres, is irrigable. As the area of the United States is 3,025,000 square miles, the arid regions embrace just half of this. The arable area of the arid regions is equal to the combined areas of the improved farm-lands of the nineteen New England, Middle, and South Atlantic States. The area of the irrigable land is equal to that of the improved land in New England, New York, and New Jersey.

Let us see now what this means in the development of our agricultural resources and the increased ability of the country to sustain population. At present there are not over 3,500,000 acres of irrigated land in the arid region, while the total acreage occupied as farms and aiding in sustaining the inhabitants is about five



VIEW ON SAN DIEGO FLUME, CALIFORNIA.

times this amount. The average amount of irrigated land on these farms is about seventy acres, while in the course of time this unquestionably will be reduced. With the higher state of development it is probable that the average irrigated farm will not exceed sixty acres, while in southern California and Arizona it will be as small as twenty acres or less. Of this area from 20 to 40 per cent. only will be irrigated. This has been the experience of India, Europe, and our own West. We thus see that with the highest degree of development 33,000,000 acres of irrigable land, at an average of say thirty-three acres per farm, would give 1,000,000 farms, if the entire area of the farm were irrigated; but as not over one-third of this would be irrigated, it may be safely stated that there

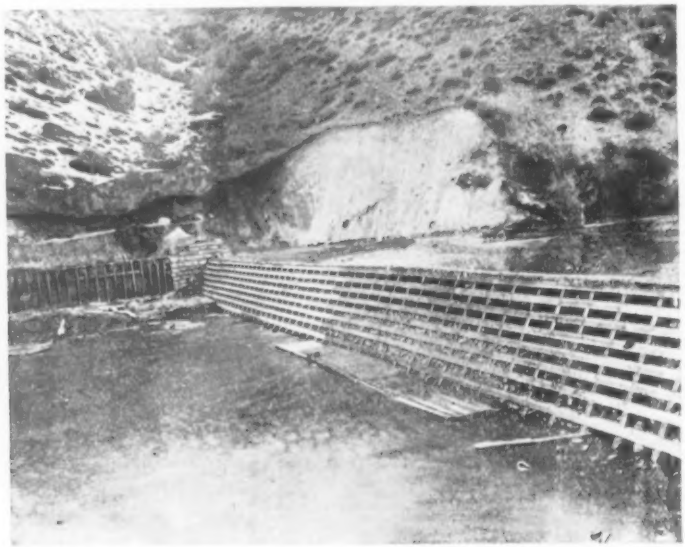


DAM AND REGULATING GATES—ARIZONA CANAL.

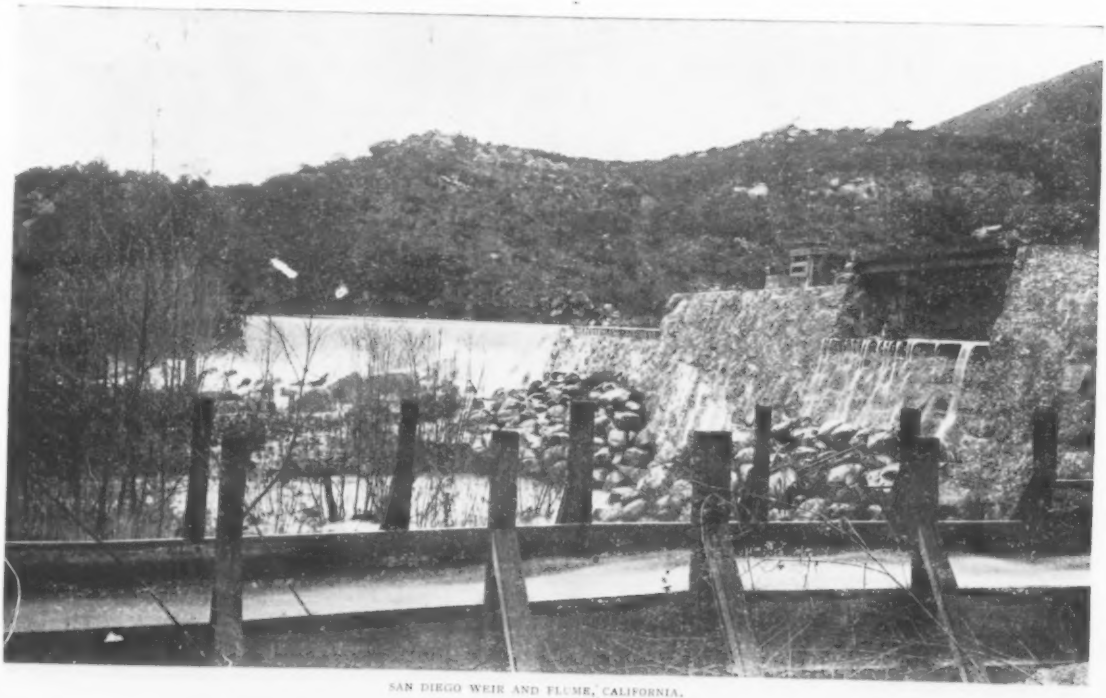
is room for the addition of about 3,000,000 farms to the 52,000 now occupied. Assuming that the highest possible state of development will never be attained, and that perhaps only 50 per cent. of it will be reached, this would give a possible addition of 1,500,000 farms, of which thirty-three acres would be irrigated, the total area of each being 100 acres. This shows a possible increase of the present agricultural resources of the arid region thirty fold; it means the support of an additional farming population of 7,500,000. The average value of farm products in the West is about $15 per acre, and 33,000,000 acres irrigated would mean the addition to the annual agricultural wealth of the arid region of about $500,000,000. Though these figures may seem stupendous, they are very much less than the earlier enthusiasts on the subject predicted and are

undoubtedly reasonable in the light of the investigations of the Census, the Department of Agriculture, and the Geological Survey.

There can be no doubt of the money value of irrigation to agriculture. Farming with the aid of irrigation is more lucrative, though more expensive, than farming in the humid region without it. The first cost of the land without the water-supply is dependent very much on the locality. It ranges from $1.25 per acre, the Government price where land is abundant, as in Montana, Idaho, Arizona, and generally through the West, to from $10 to $25 per acre, where the crops and land are more valuable, as in portions of Colorado, Utah, and California. The average cost per acre of developing an irrigation plant ranges between $4 in Idaho, Montana, and Washington, and $10 to $15 in Utah, Colorado, and California, averaging about $8 per acre for the arid region. The average annual cost of applying water per acre—in other words, the annual average water rental paid by the farmer—ranges between 75 cents and $2, reaching in some portions of southern California as high as $10 per acre. The cost of preparation of the land for cultivation, which embraces clearing, plowing, and building ditches,



WEIR AT HEAD OF BEAR RIVER CANAL, UTAH.

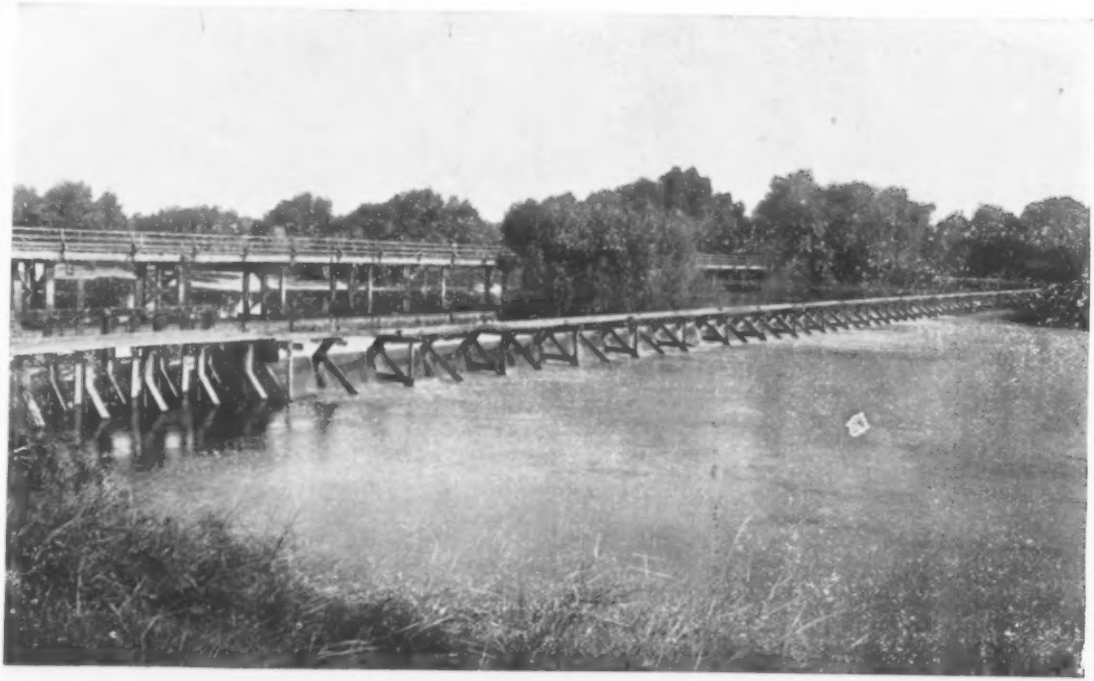


SAN DIEGO WEIR AND FLUME, CALIFORNIA.

is between $8 and $15 per acre, thus making, according to the Census returns, the average value of the irrigated land, including buildings, range between $30 and $100 per acre. Yet with this small cost land in California is valued sometimes as high as $1000 per acre, and in other portions of the West it is always several times the actual cost of its purchase and preparation.

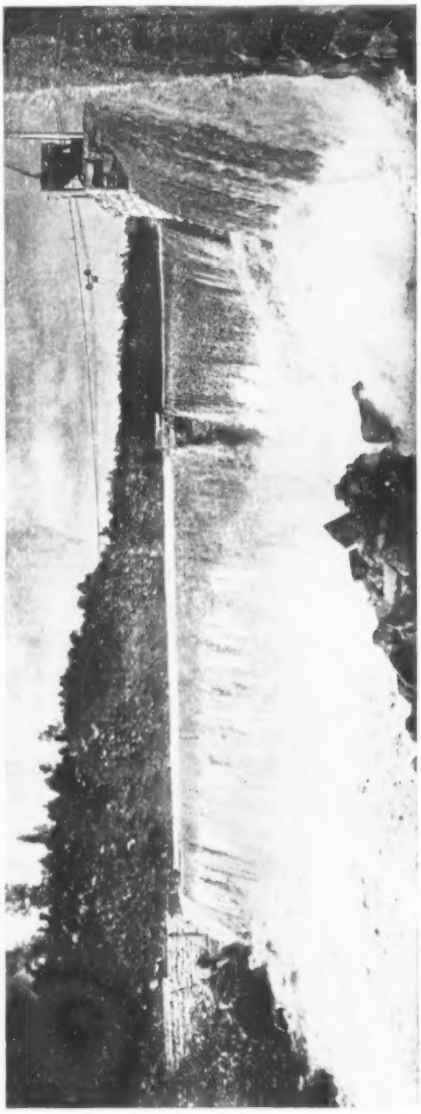
Against this cost we find that the annual average value of the products per acre of irrigated land ranges between $15 in the northern and western States, and $25 to $30 per acre in Utah and Colorado, to from $50 to $1000 per acre in California and in southern Arizona. The actual value of the returns from irrigation is much greater in many cases; it is sometimes less, according to the intelligence and enterprise of the cultivator. We hear marvelous tales of the value of orchard products in southern California,

PUMPING FOR IRRIGATION AT GREELEY, COLORADO.



WEIR ACROSS KERN RIVER, AT BAKERSFIELD, CALIFORNIA.

yet, astounding as are many of these, some of them are well within the truth. It is not an unusual thing to see a well-tended orchard produce returns of from $500 to $800 per acre, while grain and vegetable crops in other parts of the West yield proportionately large returns. The disparity between irrigated and non-irrigated lands seems at first glance too great, yet this disparity is a result of the scarcity of water and its consequent value. We find land in California which is valued at from $5 to $10 per acre for sheep-raising purposes when there is no water-supply in prospect, but let the same land be so situated that there is a possibility of developing a water-supply, and its value is found at once to be $25 or even $50 per acre; add the water-supply, and it is worth from $200 to $1000 per acre. Such prices would not be paid and could not be



DAM ACROSS AMERICAN RIVER AT FOLSOM, CALIFORNIA, DURING GREAT FLOOD.

asked if the returns did not warrant them. California is used as a single example. In Montana land that without water is worth perhaps $2.50 per acre is worth with water from $10 to $20 per acre, and between these two extremes the values vary in the arid West.

Very many irrigating canals have already been constructed in the arid region, of which about two thousand of the more important have bed-widths ranging between five and eighty feet. Their aggregate length is 9000 miles, while they have nearly double that length of laterals and distributaries. These works cost over $27,000,000, and they irrigate a total area of about 2,000,000 acres, while they command even a greater area to which water can be supplied when the demand may require it. In California, under

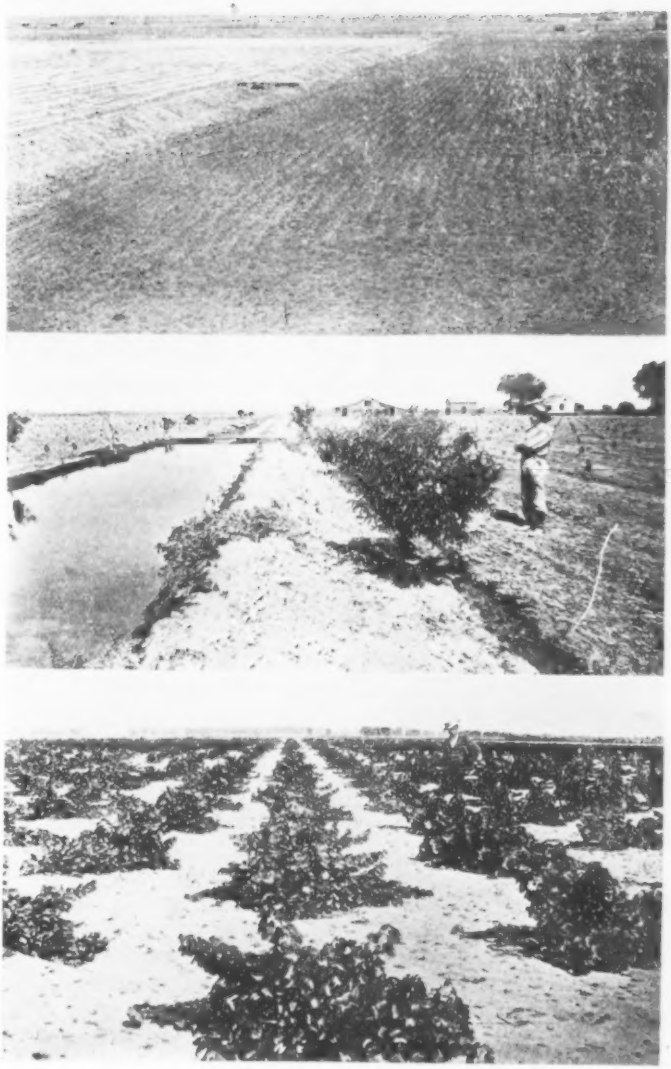
BIG DROP ON UNCOMPAHGRE CANAL, COLORADO.

the Irrigation District law, there have already been organized thirty districts containing 2,055,000 acres, for which bonds to the amount of $12,800,000 have been voted and $4,700,000 sold. On the lines of the canals already built are extensive engineering works, great diversion weirs, massive regulating-gates, long and high flumes and trestles, and many thousand feet of tunnels, besides innumerable falls, distributary heads, and minor works.

Typical among these canals, because of the important structures on its line, is the Turlock canal, in California. This is diverted from the Tuolumne river, in Merced county, and when completed will cost about $1,000,000. At the head of this canal is a great masonry dam, the object of which is to turn the water

from the river into the canal. The dam is built of rubble masonry laid in cement, and its construction will require many thousands of barrels of Portland cement, imported from England and hauled twenty miles from the railroad. This dam is curved in plan, and its total height will be 130 feet, its length 310 feet, its width on top 12 feet, and its width at the bottom 96 feet. The floods in the river are estimated to pass over it to a depth of 16 feet above its top and will have a total fall of 98 feet to the water in the river bed below; yet so substantial is its construction that no danger is anticipated from the great shock of this mass of falling water. To secure it against accident a small dam 20 feet in height has been built across the river below, and this, by backing the water up against the toe of the main dam, furnishes a water cushion on which the falling waters will expend their energy. The waters of the canal which heads immediately above this dam pass first through a great tunnel 560 feet in length, 12 feet wide, and 12 feet high, blasted through the rock walls of the river cañon. At its exit from the tunnel are a set of regulating gates to control the supply of water entering the canal, and beyond these the canal skirts the walls of the cañon for a mile and a quarter, being built up on a bench excavated in the slate rock. On its lower side the waters will be retained by an earth and stone embankment 10 feet high. Further on this canal passes for 3000 feet through a great earth-cut 80 feet in maximum depth down the bed of a creek for about a mile and a quarter, and then through a series of tunnels excavated in the hillsides. Beyond these tunnels the canal emerges on to the level irrigable lands, through which it extends like a great river with a width of 100 feet on top and a depth of $7\frac{1}{2}$ feet.

Another of the great canals is that of the Idaho Mining and Irrigation Company, which derives its water supply from the Boise river, a few miles above the city of that name. The lands which will be irrigated by this canal consist of the most arid and unattractive looking portions of the great Snake river plain,—lands which a few years ago were thought worthless even for sheep-grazing. But it has been found by experience derived from the water-supply furnished by a few small ditches that this land will produce most abundant crops of grapes, peaches, plums, grains, and vegetables. This canal heads in a dreary black cañon composed of lava rock, at which point a great dam of loose rock and earth is being built across the river. This dam is 220 feet long, 43 feet in maximum height, and 10 feet wide on top. Immediately



PROGRESS OF AN IRRIGATED VINEYARD IN KERN COUNTY, CALIFORNIA.
[First view, March, 1891; second, June; third, September.]

above it the canal heads in a series of substantial masonry regulating-gates, below which its bed is excavated for some distance in the steep lava slopes of the cañon walls. Eight miles below its head the canal reaches the irrigable lands through which it flows for seventy miles to its terminus over the Snake river, where what water remains in it is employed in hydraulic mining.

We have just seen examples of a few of the difficulties encountered in canal-construction. These canals in winding around the hillsides have, as shown, frequently to be tunnelled through great projecting masses of rock or to be excavated in steeply sloping bluffs. At other times they encounter cross drainage, where streams coming out from the hills intercept their lines. In such cases they pass these either by flumes carried on trestles over the streams, or sometimes in inverted siphons or culverts carried in the ground under the streams. The flumes or aqueducts on which these canals cross side drainage are constructed sometimes of wood and at other times of iron. In foreign countries such flumes are constructed frequently of masonry.

On the Pecos canal, in New Mexico, one of the most interesting works is a great wooden flume or aqueduct, a view of which is shown in an accompanying illustration. This flume is built across the Pecos river and carries the entire volume of water of the main canal. It is 40 feet in height above the river and 25 feet in width, the depth of water which it carries being 8 feet. Its total length is 475 feet, and it rests on substantial wooden trestles founded on crib-work imbedded in the gravel and sand of the river bottom. The approaches to this flume consist of a high embankment of earth at either end and crossing the low lands adjacent to the river bed. The first embankment which leads to the river is 1600 feet long, 105 feet wide at the base, and 24 feet in maximum height. That on the west bank of the river is 300 feet long.

At times these great canals skirt the slopes of the country, when they are given grades which the required velocity demands, and it becomes possible to keep this grade uniform by merely excavating them in the side-hill slopes. At other times it becomes necessary to run these canals down the slope of the country, in which case the fall of the latter is generally greater than that which it is possible to give the canal without producing a velocity which would erode its banks and destroy it. The maintenance of a uniform grade is obtained by inserting at suitable intervals falls or drops which let the canal down, as by a series of steps, from

level to level. These falls are usually constructed in our country of heavy timber framing, while the bed and banks of the canal above and below the fall are floored and protected by wings of wooden planking to prevent their destruction by the erosive action of the falling water. Such a fall is illustrated in one of the accompanying engravings, and shows the waters of the Uncompahgre canal plunging over two falls of 7½ feet each.

It happens frequently that the discharge of the stream from which a water-supply is to be derived for irrigation purposes is insufficient to fill the canals; in such a case reservoirs are constructed in which the storm and surplus waters are stored until required. As the irrigating season lasts but from three to four months, it will thus be seen that during three-quarters of the year the water which would otherwise go to waste may be saved. At the same time much water occurring at flood periods, even during the irrigating season, may be stored for irrigation when required. Many such reservoirs have been built in the West. There is a great range in cost per acre-foot of water stored in such works, the result of the difference in the character of the material of which the dams have been constructed and of the convenience of transportation to the site of the work.

In designing and constructing these storage-reservoirs careful and extensive surveys and examinations are necessary in order that the most desirable site for the dam may be discovered and that the volume of water available for filling the reservoir may be ascertained. In choosing the site for a dam the engineer is careful to find a place where the length of the dam shall be the least possible, while above it there shall be the largest possible basin or valley for the storage of water. On the relation of these two largely depends the cost of water storage. Sometimes the site chosen for the dam consists of deep beds of earth and gravel on which a good foundation for a masonry structure cannot be had, in which case an earth dam must be built. At other times, if the foundation and abutments are of good firm rock, and if there is an abundance of this at hand for construction, a masonry dam will be found most suitable and always substantial if well constructed. On the convenience of transportation also largely depends the character of the dam, since the conveyance of the materials required to construct a masonry dam may be so expensive as to prohibit the building of such a work.

One of the largest and most impressive earth dams yet built

in this country for the storage of water for irrigation is that closing the Merced reservoir in California. This dam is 4000 feet in length on top and 54 feet in maximum height. This great bank of earth was built up from the material hauled by carts and scrapers from the interior to the reservoir. The surface area of the lake formed by this dam embraces 500 acres, and its capacity is 15,000 acre-feet, or enough to irrigate 7500 acres of land.

An interesting dam, built of different material, is that closing the Castlewood reservoir on Cherry creek, twenty miles above Denver. This dam is built of two walls of masonry varying between four and twelve feet in thickness, between which loose rock is carefully placed. One of the illustrations shows this dam when partly completed, and above it can be seen the valley which is to be flooded by the reservoir. The total length of this dam is 586 feet and its greatest height 63½ feet. The reservoir has a surface area of 200 acres and a capacity of 5300 acre-feet. When the water stored in this lake is wanted for purposes of irrigation, it will be discharged through an undersluice in the bottom of the dam back into Cherry creek, down which it will flow for a distance of 1½ miles, at which point it will be diverted to an irrigating canal.

The most magnificent masonry-dam yet constructed in this country for irrigation purposes is that closing the Sweetwater reservoir, near San Diego, California. This dam is 94 feet high, 46 feet wide at the base, and 12 feet wide on top, its extreme length being 380 feet. At one end is a waste way through which the surplus flood waters are discharged, and an illustration shows it in operation and the water flowing from it down the cañon side and back below the dam. The capacity of the reservoir is 18,000 acre-feet, sufficient by the ordinary methods of usage to irrigate about 9000 acres. As employed here, however, this volume of water is sufficient to irrigate at least five times this amount. This is because the water is not carried and applied to the soil from open channels, but is taken from the reservoir in iron pipes, in which it is led to the lands to be irrigated.

A magnificent dam, constructed not for storage purposes, but solely with the object of diverting water into the head of a canal, is that across the American river at Folsom, California, of which a view is given, with a great flood passing over it. The view also shows the head of the canal during construction. This great dam is 250 feet long and 92 feet in greatest height, the top width being 24 feet. Over it the flood waters may pile to a height of 30 feet.

LABOR TROUBLES AND THE TARIFF.

By Charles J. Harrah.

EVER since the Tower of Babel was left in an unfinished condition—and this is the first authenticated case of labor troubles that we have on record—the question of the value of labor is the one which has occupied men's minds most, and the one which is the most distasteful to the contemplation of all men. The employer is in continual dread of the demands which he feels his hands are about to make on him for an increase in remuneration, and the workingman knows that his employer is thinking of how he can extort more products from him and at the same time pay him less money for what he actually does produce. At no time has this question assumed in this country tne proportions that it has attained this year, and at no time has it become more necessary for both employer and employed to give it sober thought and consideration than at this very moment.

During the past twelve months we have seen civil war waged in four distinct sections of the country ; troops have been called out, martial law proclaimed, and indictments for treason, murder, and conspiracy found by grand juries; lives and property have been destroyed and reckless threats made of still worse to come, —and all this in the midst of the greatest nation that ever existed in the history of the world and in an epoch of unparalleled prosperity. Surely there must be some cause for these tragedies and some remedy.

The cause is easily found. Dissatisfaction at the wages offered by the employers and the folly of a handful of ignorant demagogues on the one hand, and, on the other, tyrannical assumption of power and woful want of tact on the part of subordinates, which necessitated the indorsement by superiors of orders which would never have been countenanced by them if submitted to their approval beforehand. That the remedy for this state of affairs should be martial law and criminal indictments no thinking man will ever admit. Troops cannot be maintained for any period of time at the expense of a State for the purpose of permitting a corporation to mine coal, to run a railroad, or to operate a steel plant. Nor will a striking switchman, a miner, or a plate-roller care much about the

consequences of a trial for treason in the presence of hungry children or of a wife lacking the necessaries of life. To the ignorant demagogue who, by his invectives against the capitalist class and his appeals to the baser passions of the laborers and workingmen, has brought about this state of social disorder, a trial for treason is welcomed as an opportunity for posing as a martyr to the cause of the abused mechanic. The prosecuting attorney has lent him a dignity to which he could never hope to rise in the ordinary course of events; from being a loud-mouthed brawler, he has become a hero in the eyes of his fellow-men, and, no matter what the result of his trial, he has attained the pinnacle of his ambition.

It is at such periods, when the different trade-unions could exert such a beneficent effect upon both employer and employed, that the leaders almost invariably give proof of their total incapacity to deal with the emergency. Conciliatory efforts on the part of employers are regarded as proofs of weakness, and are met with demands which cannot be conceded without injury to personal dignity. It is unfortunately too true in numerous instances also, on the other hand, that any tentative efforts on the part of the men to an amicable solution of the dead-lock are taken advantage of by the employers for enforcing sterner conditions in the hours of labor or in the amount of wages. Nevertheless it is undeniable that the condition of the men has been greatly improved by the legislative enactments brought about by these very trade-unions, and that they are a necessary guard for the protection of the men against the encroachment of the employers. It is to them that are due the abolishment of the stores system (than which no more unjust method of paying for labor was ever devised), the enforcement of bi-monthly or weekly payments, the prevention of the employment of minors, and numberless other laws which have been passed for the social and moral betterment of the working-classes. It is therefore to the unions fully as much as to the employers that we must look for a remedy for the present evils.

Government interference in affairs affecting the relations of classes or individuals has always been resented by our fellow-citizens, and undoubtedly much of our national greatness is due to this characteristic independence of the individual; but in the present case it seems to me impossible to find a remedy without an appeal to Federal legislation. There are three measures on the side of the men and three on the part of the employers, the passage of which in my opinion would prove very beneficial.

We will first deal with the employers.

During the late presidential campaign the fact was exultingly pointed to by the orators of one party that one of the effects of the McKinley Tariff Act was the shutting-down of numerous English factories by the protective duties levied upon English imports by our revenue system. It is needless to add that this very fact was also exhibited by the orators of the other side, who gravely asserted that the shutting-down of the English mills would infallibly lead to the flooding of this country with English cheap skilled labor, and who immediately began to clamor for an exclusion act to stop the immigration of this very desirable element. Both sides showed lamentable weakness in their arguments, for on the one hand there can be no cause for exultation over the distress of our fellow-beings,—particularly the English people, who are our best customers ; and on the other hand, the nation would soon lose its greatness if it shut its gates to what is best in brains, in skill, and in pluck among the workingmen of Europe. I believe that the pauper, the criminal, and the diseased should not be permitted to join us, but I insist that the skilled mechanic, the hard-working farmer, or the man of brains and of education should always find a welcome among us. Besides, an exclusion act against the English could not be enforced. If it be difficult to guard against the introduction of the Chinese, who are comparatively few in number and so easily distinguished by their racial peculiarities, it would be simply impossible to prevent men and women of our own race and build to come over the Canadian frontier whenever it pleased them to do so, no matter how stringent our laws against them might be or how vigilant our lynx-eyed custom-house officers.

The remedy does not therefore lie in an exclusion act.

To some people it sounds paradoxical to say so, but certainly the way to keep English mechanics from coming here to compete with Americans is to permit them to stay at home. And this can be easily accomplished by the removal of such parts of the custom duties as are now depriving them of their means of livelihood by shutting down their mills. Restore to them the markets they have lost, and they will certainly be content to stay at home rather than come here to compete with our workingmen for the amount of work offering, which is already too little for the claims of the latter.

The effect of the total removal or of the reduction in part of these prohibitive duties would also have a result far beyond the

mere effacement of the danger of an invasion of foreign skilled cheap labor. It would open to us the markets which we have closed against ourselves, would reduce the cost of manufacture and extend production and consumption by lessening the price to the consumer, and would enable us to increase the number of the employed by the extension of production. An active demand for labor must necessarily result in an increased amount of wages disbursed, and the steadiness of the employment would more than compensate for any slight diminution in the wages which might have to be made in order to meet foreign competition. Steady employment at low wages is in the end far more remunerative to the wage-earner than higher wages with the certainty of a shutdown for such periods as the managers of a pool or trust, in their wisdom, may see fit to impose.

The second necessary condition is an honest currency.

It is useless to disguise to ourselves the fact that we are not honest in this matter, for the allegation that we are made dishonest by the Government's financial policy is simple sophistry. If the currency of the country is not what it purports to be, it is in our power to make Congress take such action as will make a dollar worth one hundred cents. At the present time we are exacting from workmen the full value of a good dollar, and we are paying him in a dollar that is worth less than three-quarters of what its face indicates. If the existing silver-coinage law is not repealed, it must inevitably result in a depreciated currency,—must inevitably rob the wage-earners for the exclusive benefit of silver-mine owners. This is such a simple matter that but little pressure need be brought to bear on our Congressmen to make them understand that honesty is not only a virtue, but the best policy.

The third condition is by far the most important one, and also by far the most difficult to impose. Selfishness governs our actions so largely in our intercourse with our fellow-man that it is well-nigh hopeless to expect from manufacturers any very strenuous efforts to comply with or enforce legislation regarding the sale of adulterated goods. But it is idle to expect any respect or consideration from our men if we first pay them in debased currency and then sell them adulterated goods ; and it matters not whether it be a warranted all-wool coat made of shoddy, or the finest Mocha coffee made of ground roasted corn, the dishonesty of the practice is as great in one instance as in the other, and the victim is invariably the man who has the greatest need of getting the utmost

out of the purchasing power of his dollar. As the Federal Government is strictly responsible for the employer's rascality in paying his workmen in debased money, so it is also responsible for the action of the dishonest merchant in selling adulterated goods; for the tariff has not only fostered, but it has actually put a premium on adulteration. With but little alteration it could be made to render this very adulteration so profitless to the perpetrators as to make them, from self-interest, abandon their nefarious practices. Let shoddy be taxed and wool made free, and not only will the manufacture of shoddy be discontinued, but the farmer will be able to sell his wool at better prices than ever before attained.

So much for the side of the employers. And now for the side of the men.

The most efficacious method of increasing the earning power of each individual man is for him to decline to accept any labor except at piece-work rates. Then the skilled mechanic will not be placed on the level of the awkward or clumsy artisan, for as his skill is great so will his value be to his employer. Associations and unions that work by the card are like fleets at sea; in the latter case the speed of the squadron is governed by the slowest-going ship comprising it; in the former it is generally the poorest mechanic who establishes the rate of pay of the most skillful. Piece-work not only increases the mechanic's income, but diminishes his hours of labor. Of late it has been found so satisfactory to both employers and men that in one great manufacturing establishment in Pennsylvania not only is all the manufacturing, but also a great part of the clerical work, paid for by the piece.

The second condition should be the adoption of the eight-hour system. Eight hours of honest labor is quite sufficient for any man to do. This leaves him eight hours for rest and eight hours for social intercourse. The present hours of work are entirely too long. Not sufficient time is afforded the mechanic for amusement. The adage "all work and no play" finds daily exemplification in most of our manufacturing establishments. Under the eight-hour system a greater number of men could be employed, because mills working double-turn of ten hours each could easily change to three turns of eight hours. Nor would the adoption of the system work any hardship to the employer if labor was paid by the piece. He could keep his mills going as long or as short a time as suited best the condition of his order book. At the establishment above referred to this system was put on trial for the period of several

months in one part of the forge to the mutual satisfaction of both owners and men, and was only discontinued through a falling-off in the demand for the articles made in that particular department.

In addition to this salutary change, the men should be privileged to take a holiday not less often than once a month ; it need not be necessary that the number of men employed in any one establishment should all take the same day, but the employers should see to it that their men be not kept too steadily at work, but should be made to stay away at certain intervals. The great national curse is a desire to work too much, and this should be carefully guarded against in the men. A day's shooting or fishing can be enjoyed just as keenly by the men as it can be by the proprietor, and the knowledge that he can easily obtain leave of absence by making application for it will cause the man to respect his employer's interests and be on hand whenever his presence is necessary or indispensable at the mill.

The third condition is arbitration of all labor disputes, whether they be strikes, lock-outs, or disagreements of any kind. There are of course serious objections to compulsory arbitration, but in my opinion the establishment of a court wherein these cases would be speedily and promptly settled, whose appeal would be final, and where the employers and the men would be compelled to appear in person and not by counsel, would prevent any prolonged strike or any unfair lock-out. It has unfortunately too often happened that strikes have been precipitated by the deliberate action of the mill-owners, who, by that means, were enabled to shut down their mills, work off accumulated stocks, and, when ready to start up again, get back their men at lower rates of pay than prevailed before. I am inclined to believe that the establishment of a tribunal of arbitration would make it possible to prevent and defeat any such infamous conspiracies on the part of employers, as it would also prevent the men from taking advantage of any critical state of the market, or of the conditions of a contract, to make onerous or unjust demands on the employer.

While the question of the relations between labor and capital would not by any means be settled by these reforms, still there is no doubt that both workmen and employers would be able to get on with less friction. Certain it is that no employer can expect to have the friendship and regard of his men unless he be willing to apply at the works the same rules that govern his family circle. Unfortunately sufficient interest in the social welfare of their men

is not taken by employers. They care not how the men live after they leave the mill. They do not bother themselves with the social or moral condition of their families, and their indifference for these matters is more than repaid by the carelessness of the men for their employer's interests. Few employers appreciate fully the enormous responsibilities that rest on them towards the families of their men; they do not stop to consider that the thoughtless dismissal of a man for some minor offense may cause the most cruel punishment to his family, may drive the poor fellow to drink and his daughters to the gutter; to them men are but tools, and yet from these very men they expect obedience, respect, and consideration. Many go still further and look upon themselves as benefactors for giving employment to an applicant for work regardless of the fact that they expect full returns for the wages they dole out. They concede no rights to the workingman, and in return receive no consideration from him.

That the question of wages and the remuneration of labor should be one that can never be settled satisfactorily for any length of time is easily conceivable, when account is taken of the varying conditions governing the labor market and the capabilities and qualifications of each individual; for not only must the nature of the trade and the risk to life and limb be considered, but due attention must also be given to the time necessary for the education requisite for the successful pursuit of the occupation, to the steadiness of the employment, and to the demands made upon the mental or physical endurance of the workingman.

Thus the man who works at the forge will always command better wages than he who measures ribbons behind the counter, and the miner in the coal-shaft than he who tills the field. It is a curious comment on our present civilization, however, that the two highest vocations to which a man may dedicate himself to-day are the two that bring the least remuneration. What more noble work than that of the preacher, be he priest, minister, or rabbi? What higher path in life than that pursued by the teacher? And yet he would be a poor mechanic who could not make better wages than the average of either these two, nor would he have to work so hard as they to do it. The tendency to-day is towards a lower rate of remuneration for labor of all kinds. In the higher paths the number of educated men turned out yearly by the technical schools throughout the country renders competition so keen among engineers, architects, and all those who belong to any branch of applied

science that these men, who have passed years at college preparing themselves, find that they have to accept a lower amount of pay than many a workingman gets who works under their direction. There is no doubt also that this tendency towards a lower level is hastened by the invasion of woman into the fields that have hitherto been occupied exclusively by men. From the natural gentleness due to her sex, the woman is always willing to work longer and to accept less pay than the man. We see this in the type-writer, the stenographer, and the telegraph-operator, fully as well as in the weaver, the cotton-spinner, or sewing woman who contracts to make cheap clothing at "sweater's" wages.

As it is ever the duty of the strong to protect the weak, so I believe it is the duty of every government to protect most carefully those of its citizens who are least able to protect themselves. For this reason too much pressure cannot be brought to bear upon the incoming administration to insure its most careful attention to the demands of labor, and especially to that labor that earns the least remuneration. Its aim should be not only to prevent any hastening to the lower level of the earning power of the people, but also to make their existence less burdensome by eliminating as much of the taxes as they possibly can from their shoulders, whether these taxes be in the shape of tariff or direct imposts.

The favorite cry of the campaign orator is "The free breakfast table! Let us have a free breakfast table!" By all means, say I. Everything consumed by the workingman, whether it be salt or sugar, eggs or meat, should be admitted duty free. The removal of the duty on sugar has already proved itself a blessing. The removal of duties on the other necessaries of life would increase the blessing. And not alone those things consumed by the wage-earner should be exempted from taxation, but also the material, whether raw or partly prepared, that enters into the manufacture of every article of clothing or furniture that he has need of, or that can make his life more comfortable. Flax for his shirt and wool for his blanket and his coat should be free; and his wife, when she purchases wearing apparel, should not be made to pay a tribute to the manufacturer. The bent back of the farmer is where eventually all taxes rest, and he is entitled to fully as much consideration as the wage-earner who dwells in the city. Therefore, let the tax on hemp be lifted that the cost of his binding twine may be less, and remove every duty that adds to the price of his harness, his ploughshare, and the full list of his farm implements. The mo-

rality of this policy is unquestioned ; its economic merit will soon prove it unassailable. It has been the experience of England, France, and Germany that the manufacture of woolens in their borders has been stimulated by the removal of import duties on wool. The same result is bound to follow the same policy in this country. And the rule holds good for every other article that we make. Free ores would cheapen the production of pig and the manufacture of rails. Free coal would entail the removal of the retaliation tax imposed by our Northern neighbor, enlarge our coal trade, and cheapen the cost of production in every industry. Precisely that stimulus would be felt in all branches of our manufactures which is enjoyed by the makers of india-rubber goods, whose factories would soon be closed were any tax to be placed on their raw material. Free raw material means cheaper product and increased consumption, which in turn is followed by greater demand for labor and possibly increased wages ;—and this in every line of manufacture. Our competitors would not be found at home but abroad ; and instead of waging a ruinous struggle against a neighbor in trade, our attention would be engrossed in marketing in foreign lands the surplus of our home product. A policy of liberality towards the less fortunate of our fellow-citizens must inevitably result in increased profits to those well off in worldly goods. Fairness to the workingman must bring increment of wealth to the capitalist. And especially should those industries which give employment to women be jealously guarded and permitted the most unfettered development. The greater the number of bread winners in a family, the larger the income and the greater the happiness of all its members. It is only upon the welfare of the common people that permanent prosperity can be builded.

THE GOLD-FIELDS OF BENDIGO, AUSTRALIA.

*By J. F. Markes.**

THE national emblem of Australia might well be a nugget of gold. The recital of the Aladdin-like and romantic era of the early "fifties" is ever accorded an attentive audience. The value of the gold given to the world by the Australasian colonies from 1851 to the present date—forty-one years—totals some £350,000,000 sterling, say $1,750,000,000. Of this enormous sum, which is yearly being added to by £8,000,000, the famous Bendigo gold-field has produced over £63,000,000, or rather more than one-sixth. Its quartz-reefs have a world-wide reputation, eclipsing even those of Ballarat; they have no parallel in the older continents. But it was the alluvial deposits which first attracted notice and were the sole source of the gold return from the district for the first few years following 1851.

The Bendigo valley, situate a hundred miles northwest of Melbourne, was part of the Ravenswood run in the "forties," the country having been then first taken up by Mr. Charles Sherrard, from whose possession it passed to that of Messrs. Heap and Grice of Melbourne.

The blacks, at the time mentioned, were troublesome. One can well imagine that they rebelled against the inroads of the settler, whose advent took from them a land which, though not flowing with milk and honey, abounded in kangaroo and other game, while it was strikingly beautiful and attractive. The late Mr. Robert Ross Haverfield, one of the pioneers of Bendigo, in describing the valley in the period ante-dating the gold-diggers' advent, said:

"The flats, carpeted with green grass, were dotted here and there with comely and shady gum-trees, while the creek-banks, shaded with wattle, sloped down to a chain of water-holes, which in the spring and winter seasons, and indeed all the year round, contained a good supply of clear, sweet water."

* Mr. J. Francis Markes writes from information gathered by him as an expert during his frequent visits to the Australian mining centers, and in his position as managing editor of the *Australian Mining Standard*. This article was written at Bendigo, and brings up to the latest date the record of occurrences there. These phenomenal fields of gold, following a period of depression, are causing the growing excitement that characterizes the early stages of a "boom."—THE EDITOR.

It is matter for wonder that the blacks never discovered the presence of gold, or at least that the most ornamental of metals was unused by them, for they can scarcely have been ignorant of its occurrence. The reef outcrops must surely have been familiar to the most cunning bushmen in the world. But the fact remains that no mention is made by the early colonists or by explorers in any part of the main continent, Tasmania, or New Zealand, of golden ornaments being found among the aboriginals. The negro of Central Africa is equally careless or ignorant of the precious metals, as the writer discovered in a conversation with Mr. Henry M. Stanley, who in his travels has only seen it in possession of the Arabs, of all the savage tribes he encountered.

Messrs. Gibson and Fenton held the Bendigo run in 1851, at the close of which year gold was discovered at what is now known as Golden Square, and the transformation of bush to camp and camp to city began. At that time the news had just reached England of the Ballarat and Castlemaine rushes, and consequently of the exodus which took place from the Old World for them.* Bendigo had its share even before its own trumpet had been sounded abroad. The face of the land changed almost in a night, and the visitor of to-day gazes in wonder at the troubled surface which for miles encircles the town. Legions of shallow holes, with accompanying gravel dumps, rounded and smoothed by time and weather, but still bare of grass, meet the eye in all directions, and it is hard to realize that untold riches once lay there waiting for the pick and shovel. The plain unvarnished records of the hills and gullies read like a traveler's tale; one sighs half incredulously and half enviously at the perusal. Mackay, in his "History of Bendigo," says:

"Gold was dug up almost in bucketsful on Bendigo flat. Two young men one morning sank a shallow hole at the foot of the first White Hill and from one pocket in the slate took up fifty pounds weight of the precious metal. Ironbark turned out a huge quantity of gold, and numerous holes in that gully were appropriately called 'jeweler's shops.'"

Water of course was necessary, and in large quantities, for

*In 1852 Lord Robert Cecil, now Lord Salisbury, visited Australia on a pleasure trip around the world. The fever of digging was at its height, and the nobleman ere long possessed some realistic experiences of a mining life, for he assumed the digger's dress, worked with pick and shovel, and cooked his own damper,—not simply for the fun of the thing, but under the influence of the absorbing excitement which at that time carried every one away.—THE EDITOR.

separating the gold from the containing gravel, and here a great drawback existed, for on the field proper there was practically no water for any purpose, and much sickness was soon traceable to this cause. The dirt had often to be carted eight or ten miles to special water-holes, and the exploiting of one of them with a small dredge in later years realized a small fortune to the long-headed men who ventured on the speculation.

In 1853 the enormous yield of 661,749 ounces was recorded, and this may be safely increased to 700,000 ounces to represent gold taken privately to Melbourne. This was all from the alluvial, but by the next year, 1854, some notice had been taken of the quartz reefs which were discovered as the scrub and undergrowths were cleared away, and by 1860 considerable progress had been made in their development. A brief reference may be made here to the subject of the deposit of gold in alluvial, with special reference to nuggets, some of which have been found in Victoria of a value individually of more than £9000. Among scientists in Australia the most generally accepted theory with regard to their origin is that, just as experience has shown that reefs become poorer in gold as they go down into the earth, so it is probable that the richness of their higher portions from the outcrop of to-day to that on the original surface untold ages ago was greater than that of any existing formation, probably to the extent of the lumps of metal now known as nuggets being embedded in the matrix. Given that, we may imagine that as the earth's crust was gradually worn and washed away (chiefly, no doubt, before the vegetation period) the disintegration of the reefs set free the imprisoned gold, which was subsequently carried by the washing of rain and floods to the sites wherein it is now found, and was itself worn smooth (water-worn as miners say) in the process.

For an approximate estimate of the richness of the reefs which once carried the famous nuggets from the Welcome and Welcome Stranger (formed at Ballarat and Moliagul) downwards, we must have recourse to our imagination, aiding that faculty by the remembrance that Bendigo and other fields showed thirty years ago quartz yielding even 1000 ounces of gold per ton, and very commonly eight to ten ounces. At later dates, however, under economical conditions of reduction, one-ounce stone has been thought highly profitable, and many mines have even paid dividends on 6 dwt. to 8 dwt. stuff. At the time of this writing the Johnson line of reef is on three-ounce stone at 1500 feet, and the

New Chum United Company at 2000 feet has similarly rich stuff, but these are unusual occurrences.

When, in 1854, the attention of speculators was directed to the reefs, much public interest was aroused and the miners were encouraged by the press, to which quartz-mining, like many other important industries, is overwhelmingly indebted. Mr. Haverfield, then editor of the Bendigo *Advertiser*, endeavored by means of forcible writing to convince the diggers that they should look to the reefs from which the gold in alluvial had already come for a continuance of their prosperity. And we must not permit the acquired wisdom of to-day to lead us to think slightingly of the men who, accustomed to the surface scratching or at most shallow sinking, hesitated to tackle the new work of reefing.

Machinery was evidently a first necessity,—expenses for an excess of those incurred in alluvial mining had to be met,—and all in the face of the fiat of Geology (in the person of the eminent Sir Roderick Murchison) that no gold would be found below one hundred feet. Later on certainly, as nature's secrets were uncovered to that depth, the men of science grudgingly accorded another hundred feet as the limit for the gold-seeker, and to-day, when 2000 feet has not defined it, a theory is current that at the granite substratum the reefs will finally and permanently cut out. Possibly in Victoria they may, but in Queensland the renowned reef of Charters Towers and some other fields are in a granite formation from the surface.

The discovery of golden stone on Bendigo is placed to the credit of two colored men, who found an outcrop on Victoria Hill at the end of 1853. They soon sold out to Mr. Theodore Ballerstedt, who in six years cleared £243,000 from their claims, while various small holders on the same hill are said to have realized £600,000 concurrently. These fabulous figures might have been even larger if the miners had not been handicapped by the great cost of labor (£1 per day), crushing (£6 10s. per ton), and inefficient gold-savers.

The Ballerstedt estate on Victoria Hill was bought subsequently by Mr. George Lansell, the quartz-king of Bendigo, and his mines there are known as being on the New Chum line, the farthest west of the famous trio of reefs which have made Bendigo (under the name of Sandhurst) famous. These three main lines of reef are the New Chum, the Garden Gully, and the Hustlers, and while there is space in this article to refer to these

alone, it must be understood that there are numerous other parallel veins. These three reefs run about 20° west of north, and, roughly speaking, have been or are worked for a length of five or six miles each. Their great peculiarity is their "Saddle" formation. They exist in this form at the southern end of the lines, and occur in regular series one below another to all depths yet reached. The apex of the saddle is generally poor, while the legs are richer, but apparently no precise rule can be laid down as to the deposition of the gold. It runs in shoots, and a barren stretch may at any time give place to a gold-bearing patch. The quartz throughout the district is, generally speaking, of a clear white character, mottled with slate near the walls, and commonly thickly impregnated with pyrites, galena, and blende, which usually occur in veins or laminations, in or near which most of the gold is found, though it can always be discovered also in the body of the stone. Many very beautiful specimens showing the rich metal protruding from the quartz are met with.

The northern part of the field presents evidence of fierce disruptions, and both the reefs and the encasing strata are much broken, the quartz veins frequently appearing as mere threads in the slate. They are called "spurs," and it is no uncommon thing to see taken out in such formations a stoke forty feet wide, the richness of the leaders of quartz paying for the removal of the rock, which has filled a large proportion of the space.

The Garden Gully line is five hundred yards to the east of the New Chum line, and the mines working on it include the Garden Gully United Claim, which has paid £1,000,000 odd in dividends, and many others out north to the Johnsons Company, and further still the New Moon, which is now working payable "spurry" country at a depth of 684 feet, nearly seven miles from Bendigo post-office. The Hustlers line lies about the same distance further east, and is worked by the several companies bearing the name, of which the Great Extended Hustlers has paid nearly £700,000 in dividends. The Eaglehawk group of these mines takes in the northern section of the lines.

Bendigo had a "boom" in 1871 to 1874, and, in consequence of the over-speculation of that feverish period, a decade of depression fell upon the district. Large numbers of mushroom companies had to suspend work or were swallowed up by more powerful concerns. The year 1884 saw another revival, and now, after a further interval, the result of the splendid developmental work which has been

UNDERGROUND VIEW IN A MINE IN THE "SPURR" COUNTRY, SHOWING QUARTZ VEINS.

undertaken is evident to a gratifying extent in the increased yields derived mainly from new strikes of reef at great depths.

There are now on Bendigo twenty-four shafts 2000 feet deep or more, the deepest of them being that of the "180" mine owned by Mr. Lansell, a Bendigo millionaire. It is now down 2850 feet, and cross-cuts are being driven at 2800 feet. Should they strike a paying reef, very great excitement will be manifested. Ten of these deep mines are now yielding golden stone. The list includes: the New Chum Railway, New Chum United, Old Chum, Garibaldi, Lazarus,

STOPE SHOWING "CAP" OF A SADDLE REEF.
[From a photograph taken in a Bendigo gold-mine.]

and Great Central Victoria. The fact that six of them are on the dividend-list and that several more will probably be added to it is convincing proof of the remunerative character of quartz-mining at great depths. But all the gold is not coming from the deepest mines, or from the lowest levels, for prospecting in ground which has previously been left has proved in several cases highly remunerative. Thus at the New Red, White, and Blue mine on the Sheepshead line £51,000 has been paid in dividends from a run of country at 700 feet previously thought worthless. At the Catharine Reef Eaglehawk at 560 and 736 feet splendid spurs are being met

GARDEN GULLY LINE OF REEF, LOOKING SOUTH FROM KOCH'S BATTERY.

with far west of old workings at those levels. An underground survey is now being made by Mr. E. J. Dunn of the Victorian Department of Mines and a staff of officers. His task is the continuation of previous work by other geologists, now some years old, only recording the development at comparatively shallow levels.

The immense amount of mining done since has enabled Mr. Dunn to complete surveys of considerable lengths of country, and his preliminary report recently presented to the Minister of Mines

TANSELL'S FAMOUS [illegible] MINES, AND PART OF THE NEW CHUM LINE.

recorded his conviction that payably auriferous reefs will be found to exist for many miles beyond the present workings. A practical present proof of the value of the deep ground is attested by the splendid fortnightly returns, and it is probable that for the year ending December 31, 1892, the dividends will equal a return of 20 to 25 per cent. on the whole enormous working capital of the field.

Bendigo has long since created its millionaires. The late Mr.

THE CITY OF BENDIGO, FROM THE HOSPITAL HILL.

J. B. Watson is supposed to have taken *twenty tons of gold* from the Kentish mine in fifteen years, representing a money value of £2,500,000. One "Christmas cake" from this mine weighed 6500 ounces. Mr. Watson's memory is not very highly honored in Bendigo, for all that, as he spent or invested all his wealth in and about Melbourne. Mr. George Lansell, on the contrary, is a thorough Bendigonian, living amid the roar of his beloved stampers, and overshadowed by the huge poppet-heads of his pet mines. Mr. Lansell was originally a soap-boiler, and, if tradition is to be trusted, earnestly eschewed mining until some scrip which had come into his possession for a bad debt suddenly brought him in rich returns. He has been for many years the recognized stay of the

THE TOWN HALL, BENDIGO, AUSTRALIA.

PALL MALL, BENDIGO, WITH FOUNTAIN PRESENTED TO THE CITY BY GEORGE LANSELL.

VIEW IN THE PUBLIC GARDENS, BENDIGO.

district, and, while his returns have no doubt been enormous, he has spent very many thousands of pounds in deep sinking, and dead work generally, in the host of mines with which he is connected. At present his dividend account is being added to by £2000 a week, at least. He was sixty-nine years of age on August 24, on which date the Union Jack was hoisted at all his private mines. Mr. Barnet Lazarus, Mr. Latham, and others have also benefited very largely by the Bendigo reefs.

The city of Bendigo is well laid out and well built. The Post-Office standing on the north side of Pall Mall is a very handsome pile, and the School of Mines, town-hall, hospital, and other buildings are worthy of inspection. Most of the streets are planted with trees, and a steam-tram runs from the railroad station to Eaglehawk, a few miles away,—a municipality which has earned locally the name of "the model borough."

THE WORLD'S FAIR AND THE DEATH RATE OF 1893.

By James C. Bayles, Ph. D.

THERE is every reason to expect that the World's Columbian Exposition will attract to Chicago in 1893 a vast multitude of people. Estimates of totals are of no consequence in the present discussion. Convenience of access, abundant transportation facilities, and extraordinary attractions insure a very large attendance of visitors, even under adverse conditions.

It is safe to assume that nine hundred of every thousand making up the grand total will remain in or near Chicago no longer than is necessary to accomplish the object of their visit. They will make the journey to and from Chicago on return tickets without stop-over privileges, and in the least time practicable. On arriving in Chicago they (the 90 per cent. of the total) will so plan their movements—or move without plan, as the case may be—as to utilize every available hour, and see as much as possible. They will not want to "miss anything." Having "seen" the Exposition, they will hurry home—satisfied. How they live while there will be a consideration wholly secondary to the main fact of getting to, being at, or having been to the Exposition.

There is enough in this brief summary of familiar and commonplace facts to suggest much anxious reflection. One need not be a student of vital statistics or a physician of wide observation and experience to understand the immeasurable and inestimable danger to life and health which will inevitably attend this vast pilgrimage. If I should say that the cost to the nation in sickness and deaths, measured by well-recognized economic standards, would probably exceed the material benefits of the Exposition, I think I should be beyond the reach of intelligent contradiction.

It is not the purpose of the writer to criticise or discuss the sanitary condition of Chicago. Generally speaking, it is much better than is commonly assumed by those who criticise it. The people of that wonderful city seem to have recognized their responsibilities in this instance, and to have made such provision as a wise forethought could suggest to insure healthful conditions. To improve the water-supply, a tunnel has been pushed four miles into

Lake Michigan, constituting an intake far beyond the range of probable sewage pollution. The new drainage system lately undertaken will not be completed in time to benefit the city during the Exposition, but the existing dangers from bad drainage are not such as to warrant grave alarm. Chicago is not an unhealthful city. Its vital statistics show a uniformly moderate and fairly normal death-rate. As to such local and current measures of public sanitation as street-cleaning, the suppression of nuisances, and precautions against the spread of contagious diseases, we may safely assume that these will be looked after more carefully and thoroughly than ever before. There is an especial incentive to municipal zeal in the fact that the cholera has this year "knocked at our doors," and that its reappearance next spring is threatened. A cholera panic at Chicago would be easily started in 1893, and would paralyze all efforts to make the Exposition a success. It is by no means certain, however, that the basis for such a panic will exist in 1893. Cholera reached the Quarantine station in New York harbor in 1887 in a very serious way. Its reappearance in 1888 was predicted and expected, but it did not reappear.

It is unnecessary, therefore, without better reason than we have at present, to assume that several millions of people cannot visit Chicago in 1893 as safely as they could have visited New York or any other large American city which might have secured the Columbian Exposition. But were Chicago as perfect in its appointments as the dream-city of Hygiea, the fact will remain that an appalling mortality will attend the movement of population due to the Exposition, unless it is possible to educate the American people, very quickly and very thoroughly, in matters to which they habitually give but little attention.

At no time are the conditions of transient residence in a city so abnormal and so generally uncomfortable for the transient visitor as during an international exhibition. It cannot be otherwise in Chicago. There will be food enough, and probably beds enough. The provision in both cases is likely to exceed rather than fall below the average requirement for the Fair season. But anything approaching comfort will be had only at high cost, or as the result of a prudent foresight. For a vast majority of visitors the former will be impossible, the latter improbable. Those who have desirable accommodations to offer cannot afford to hold them subject to the precarious occupation of chance comers for brief periods. For these there will be the temporary structures and ex-

temporized boarding-houses which no municipal sanitary code would sanction, and no board of health tolerate under any other conditions, and the cheap restaurants, where badly-cooked and generally inferior food is served. We need waste no time in suggesting plans by which these evils can be avoided. They will exist for the reason that they will be needed, and that without them thousands would go hungry by day and sleepless by night. All that the City of Chicago or the management of the Exposition can do for the public comfort has been, or will be, done. The evils from which the average visitor is likely to suffer will be due to causes for which he is chiefly responsible, and from which he cannot be protected without involving an attempted restriction of personal liberty quite impracticable under our laws.

To understand the nature of the dangers which will menace life and health during the Exposition, and how they will be encountered, we must follow in imagination the movements of a group of persons fairly representing the great average of Exposition visitors, who come to Chicago under averagé conditions. The group comprises a man and his wife, two children,—say a boy of fourteen and a girl of twelve,—a single woman of thirty-five or forty, related to the family, and an old lady, grandmother of the children. We have here a characteristic family group. Our friends belong to the great middle class of representative Americans. They are by no means rich, nor can they be considered poor. They are used to comfortable living. For the necessarily considerable expenses of the trip, what is deemed a sufficient provision has been made. It is a great event in the family life, and warrants some sacrifices.

The journey by rail to Chicago is made without accident or unusual discomfort. It is not the best possible preparation for the fatigues to follow, but there is a pleasant excitement about the journey and its object which is sustaining, and even stimulating. Chicago is reached with all the party in good spirits, and they plunge at once into a whirl of excitement. The head of the family is practical. He knows that the first thing to be done is to find lodgings for the party; places in which to eat can always be found. The hand-bags, extra garments, and umbrellas must be disposed of before they can be foot free. He soon finds, however, that he has anything but an easy and comfortable task in hand. If he had any prearranged plan, he is likely to abandon it under the volunteered advice of runners and agents who will cordially coöperate in the effort to confuse him and get ladies of the party excited. He

is made to believe that the city is especially crowded, that a search for a boarding-house would be hopeless, and that the only accommodations left are those offered him by his tormentors, and which he is urged to accept before the next train arrives, or it will be too late. The wife believes this even more implicitly than does the husband, but the runners who have determined to capture the party make sure that he shall have little time for reflection and less for consultation. The position is embarrassing for all concerned. The children are becoming restless and impatient. It is only for two or three days, at most. The land of enchantment—the wonderful exposition with its untold marvels of beauty and interest—awaits them. They cannot get there too soon, and to haggle over details is to "burn daylight." The head of the family decides according to his light, and they are hustled off to a barrack where they find two alleged "rooms." If dissatisfied, they are solemnly assured that hundreds are at that moment wandering the streets without a place to sit down, much less to sleep, and that this will be their portion if they let slip this fortunate chance. The two rooms are little larger than closets, and are separated from other rooms by seven-foot partitions. Such accommodations are better than none, and to-morrow morning something more comfortable can be looked for.

"Never mind; we shall see the fair. Hurry! Hurry!"

The children cannot be longer restrained; and since a place has been found and engaged, nothing will be gained by wishing it was different. To reach the Exposition by the shortest route and in the least time is the thing most desired.

"We can get some lunch there; nobody is hungry now."

We will not follow the party in their wanderings. Once within the Exposition grounds, fatigue is forgotten and hunger disappears. Incidentally the party refresh themselves with such pastry and light beverages as can be secured from the counters, and the children are liberally supplied with confectionery. Hour after hour on foot, pressing forward, darting to right or left to see some new or strange thing,—so the memorable day passes. As it draws to a close each member of the party realizes for the first time a fatigue so absolute and overpowering that no previous remembered experience can be compared to it.

Supper! They are too tired to look for it, and turn into the first place they come to. The windows are attractive, the prices high, the food bad, the table furniture dirty, and the service unspeak-

able. Even the chairs might have served the Holy Office as inquisitorial instruments of torture. The party are too tired to eat. They have lived all day on cakes, lemonade, and sugar, and even well-cooked and savory food would be unwelcome. The supper is perfunctory. To be home again is the dearest wish of each, but no one gives it expression.

Back to the barrack, and now for the first time the "picnic" assumes a really serious aspect. It must be two in a bed, and the children on the floor. Perhaps, however, the children are better accommodated than the adults. The beds are narrow, ridgy, and utterly uncomfortable, the atmosphere is foul, and adequate ventilation is impossible. It is long after midnight before the place is quiet, and morning finds the party in a sorry plight. Swollen and blistered feet which can scarcely be crowded into shoes, aching limbs which totter and tremble, heads that "swim," dull eyes, nausea, and general disgust,—how different these from their accustomed morning sensations at home! The boy is cross and unreasonable; the girl is fretful and feverish; the grandmother "bears up wonderfully," but feels much worse than she admits. Father, mother, and aunt hold a whispered conference. To return home by the first train would be wise, but it would be a pity to have come so far for so little. They have not even looked into half the buildings, or seen half the things they have heard or read about. Says the father: "We went it a little too strong yesterday. To-day we will take it easier. We will all feel better after a good breakfast."

The second day is much like the first, but perhaps even more exhausting, notwithstanding the frequent rests. Great thirst and no appetite for wholesome and digestible food show the effects of continued strain. Every member of the party, if at home, would be put to bed and placed under the care of a physician. They sleep better the second night, but it is because utter exhaustion renders them insensible to discomfort. On the third day the grandmother finds herself unable to go out. She insists she is not sick, but it is better not to overtax her strength. It is their last day, and they mean to go about the city some. They "have not seen half the Fair," but it cannot be helped. They must get home for the sake of the old lady and the children. "Only one night more, thank goodness!" At last it is past, and the unhappy party drop into their seats in the returning train. No journey ever seemed so long or so tedious, but it brings them home at last.

Thus far we have followed a typical party through three days

and nights of typical experience. If we follow the same group a little further, we shall probably find something less entertaining but more instructive. All will be more or less sick as the result of this disastrous excursion, and two deaths will probably result from it,—one directly and one indirectly. Should the whole party die within a week, it would be unfair to blame the city of Chicago for the resulting mortality. The curiosity which is one of our national characteristics will not only take to Chicago thousands of old people, sick people, people with well-defined predispositions to disease, convalescents not yet strong enough, women in a condition demanding rest and freedom from excitement, young children and others who should not go at all,—but it will lead those who are perfectly able to go to such over-exertion, imprudence, and exposure that wide-spread and far-reaching resulting evils are inevitable. We had an illustration of this during the Columbian celebration in New York in October last. Whole families passed the three days of this municipal nightmare on the sidewalks. Those who had witnessed the day parades waited for the night parades. Men, women, and children were jammed in solid, surging masses, often from early morning until long after midnight. It was saddening to observe the sacrifices which people with no other incentive than curiosity made to see these very unsatisfactory pageants. For very many, the risks were greater than those faced by the soldier in a desperate battle. Who can estimate the after consequences?

Most of us remember very well our own experiences, or those of our friends, at Philadelphia in 1876. That these will be repeated in Chicago on a much larger scale cannot be doubted. A large percentage of the total of transient visitors will be people who should stay quietly at home. They cannot afford to go in the only way in which it is possible to go comfortably and safely. Another large percentage will include those too old, too young, or too feeble from disease to incur without imminent risk of serious illness or death the fatigues and exposures which cannot be avoided by those who see the Exposition even superficially. Eliminate these two great classes of visitors, who should stay at home, and the problem would be greatly simplified. But they cannot be eliminated. Not only will they suffer immediate and more or less permanent physical evil, but they will increase the care, anxiety, and fatigue of the stronger ones upon whom they depend. To see the Exposition will, no doubt, be a great privilege, and to enjoy it will war-

rant reasonable sacrifices; but to paraphrase the medieval proverb so that it shall read, "See Chicago and then die," should not commend itself to the approval of so practical a people as ours. Those who are not well prepared to face all the fatigues and dangers which can be crowded into the period between leaving home and getting back again should stay at home, or be left there. But in most cases this knowledge will be gained only from costly and long regretted experience. Those who should not go are, as the rule, the ones who will want to go most, and will feel most keenly the disappointment of being left behind. It will seem so easy to go, and so difficult to arrange to leave the unfit ones at home. When it is over, all concerned will be wiser and family circles smaller.

That old people, feeble people, and children will suffer first and from causes more directly traceable to the great pilgrimage is in accordance with nature's laws. The fertile germ of typhoid fever will be planted in a thousand new centers of favorable development, and the aggregate mortality from this cause it would be neither easy nor pleasant to estimate. Probably there will be no important increase in the percentage of deaths from typhoid in Chicago in 1893, and the good people of that city may indignantly deny that Chicago had anything to do with the increased mortality from typhoid elsewhere. It is not necessary to discuss this question. People who are in a condition of peculiar susceptibility to the germs of this disease may pick them up almost anywhere. I do not recall that the vital statistics of Philadelphia in 1876 showed any important local increase of deaths from typhoid fever; but I do remember very well that thousands returning from the Centennial carried this disease with them, and that a large mortality resulted from it in places where it had been previously little known.

Every variety of diarrheal disease may also be expected to prevail among returning visitors who have "seen the fair." They will be accounted for by excessive fatigue, imprudent eating and drinking, unaccustomed exposure to sudden changes of temperature, and specific infection from untraceable causes. Contagious diseases, especially those varieties to which children are most susceptible, will be widely distributed. Deaths due to the aggravation, by fatigue, exposure, and personal imprudence, of pre-existing weaknesses or slow-developing chronic diseases, will help to swell the total. Finally, if we assume, as the facts of average experience

warrant, that for every death we shall have five cases of more or less serious illness which do not terminate fatally, the net results of the Exposition, as viewed from the standpoint of the vital statistician, are likely to be very costly to the country.

These are gloomy predictions, but unfortunately they are not exaggerated. They are warranted not by any conditions peculiar to Chicago, but by the fact that an event which should anywhere assemble a great concourse of imprudent people, who not only do not know how to take care of themselves under unusual conditions, but who would break through all safeguards which might be suggested for their protection, cannot result otherwise than as we have shown. To formulate a code of rules suited to the requirements of all classes of visitors to the Columbian Exposition would be very difficult. I certainly should not attempt it, but some suggestions to serve as a basis on which intelligent people can construct rules for their own guidance may be of value as a contribution to the deluge of Exposition literature.

I. *Before going to Chicago to visit the Exposition, determine whether you are physically able to go, and can afford it.* In deciding these points one may safely assume that a great deal more strength will be needed than is required for the normal hard work of life; and that to go and return will cost a good deal more than one would expect to find sufficient.

II. *Take with you no one for whom you are responsible, without the approval of your physician.* It is safe to assume that from one-third to one-half the people who will go to Chicago from distances greater than fifty miles would be advised by any capable and conscientious physician not to go, if such advice were asked.

III. *When you reach Chicago, make it your first business to secure wholesome and comfortable lodgings.* Under such circumstances, the average person needs a great deal more than a place to sleep. It is impossible for any one to keep up for two or three days the tension of eager sight-seeing without needing something more than a bed in a closet to retreat to when he can go nowhere else. In finding lodgings, the visitor who has made no arrangements in advance would do well to avail himself of established and recognized agencies of information, and to reject all interested advice or personal solicitation.

IV. *Avoid excessive fatigue.* The sense of being tired is nature's warning that the physical powers are being overtaxed. The most fatiguing thing on earth is a great Exposition. A rapid successi o

of vivid and exciting impressions stupefies the brain and emphasizes the mere muscular fatigue of walking and standing for consecutive hours. When the interest flags and physical fatigue asserts itself, go where you can rest.

V. *Eat regularly, lightly, and frequently, keeping strictly to plain and wholesome food.* The advice of a physician on this point, obtained before starting, will be of great use to you. The fact that "the doctor said so" invests the simplest and most familiar hygienic rule with an *ex cathedra* authority.

VI. *Drink moderately and carefully, avoiding unknown or unaccustomed beverages.* Generally speaking, aerated waters in siphons are the safest and most refreshing drinks available to transient visitors in cities. The mischief done when crowds assemble in summer in America from the floods of ice water, soda, lemonade, and nondescript bottled stuffs imbibed is simply incalculable.

It may occur to the reader that the rules above suggested are the veriest commonplaces of hygienic advice. So they are; but it is just because they are systematically disregarded by average people under the excitement of strange conditions that great pilgrimages such as we look forward to in 1893 are so fatal. If reasonable people who go to Chicago would exercise while there the self-restraint and sound practical common sense which characterize the regulation of their daily lives at home, we might safely dismiss all anxiety on their account. Only the fools would suffer, and perhaps society would lose nothing by their prompt elimination. But we must deal with facts as we find them, and no fact asserts itself more obstinately than that the average citizen who goes to the Columbian Exposition will needlessly increase the danger he necessarily encounters by contributory imprudence or negligence.

Every right-minded American citizen hopes that the Columbian Exposition will be a great and creditable success. That its educational value may be availed of demands that all classes of the people should be represented among its visitors, and that they should be counted by millions. But it is the duty of the thoughtful to warn the thoughtless that under no circumstances does the law of the survival of the fittest find such emphatic demonstration in prompt and impartial operation as during a great Exposition.

ARE AMERICAN MECHANICS BOASTERS?

By T. F. Hagerty.

DURING my recent absence in Europe there was widely published in this country an article by Professor John E. Sweet, charging Americans with boasting, and calling upon us "to pause a moment in the self-glorification to which success has made us prone, and consider a little more humbly just where we stand." If this charge of boasting be true, it is time for us to reflect upon the disparaging influence it would have upon the efforts of our manufacturers and merchants to introduce American productions into European markets. But I hold that there is no real foundation for such a charge. On the contrary, we do not give due credit to our own manufacturers and inventors, but have, until recently, kept the names of all the noted scientists, inventors, artists, authors, mechanics, and statesmen of Europe prominently before the American people. There are few of our old mechanics who are not familiar with the early efforts of the English mechanical engineers and inventors of mechanical tools. The names of Whitworth, Maudsley, Roberts, Nasmyth, and many others are as familiar to American machinists as to their English brethren.

I have traveled all over the world, and have met all kinds of Americans at home and abroad, and I have failed to hear any boasting except when they have been called upon to defend our institutions and industries against the attacks of boorish Englishmen who refer to everything American as "Yankee humbug" or "worthless Yankee trash." But this is not the first time that I have heard the charge of boasting made against us. In the Australian Colonies, as well as Great Britain, I have constantly heard the remark: "You Yankees are the greatest boasters on earth; you give no other nation credit for anything." When asked to name the particular instances of boasting, and to state wherein we make claims to any special superiority, they would invariably refer to the utterances of some American politician, but never to one of our mechanics. After forcing one into a discussion as to the merits and demerits of American mechanical productions, they would boast in the most vainglorious manner of the

wonderful achievements of old England and the superiority of her manufactures over all others, and especially those of America.

Professor Sweet is so deeply absorbed in what other nations are doing as to be unmindful of the fact that for many years our Government has been engaged in *just what he claims that we are not doing*. He writes:

> While this is the greatest century of all centuries in the advancement of what we suppose to be general civilization, and what is certainly industrial progressive civilization, and while this nation is moving on side by side with other nations, does any know less of what others do than we, and are any so stupid about profiting by what others are doing? Or if other nations are so thoroughly convinced of their merits, do they not keep their convictions more to themselves?

Is it possible that he, as a teacher, has been unaware of the fact that the shelves of every American library hold many volumes of reports from our Consuls in nearly every part of the world? The information contained in these volumes covers every conceivable subject, and they are of the greatest importance to nearly every branch of American industry. The only surprising thing in this connection is that, instead of being accused of not profiting by what others are doing, we are not reprimanded for prying into the public and private affairs of the people of other nations. In a recent Consular report I find that the Government has actually instructed its agents to inquire into the manufacture of gas in their various stations,—the original cost of plant, cost of coal, wages paid, and profits derived from products. Now it would be as much as the lives of foreign Consuls are worth should they attempt to "get behind the returns" of a gas-company in America.

> Among the things most boasted about, and upon which we have the most reason to pride ourselves, are our mechanical inventions and the products of our mechanical engineering establishments.

So Professor Sweet admits that we have reason to "pride ourselves" on our mechanical inventions and other productions, and even boast of them; and as if to show how incongruous one can be when swayed by a faultfinding desire, he presents a list of things made in Europe covering nearly everything made in our mechanical engineering and other establishments, which he says are better made and better finished, of better material and better workmanship, and more economical, all of which originated or were invented in Europe, and that nothing further stands to our credit "in advance of precedent than rolling tubes from the solid bar."

"In noting the things that we surpass the world in, it will be well to balance them against the following on the other side,"—and

he proceeds to catalogue the details of our inferiority. Now if the foregoing statement of the lack of originality of our mechanical and other productions be true, then there is nothing left for us to balance; in the expressive language of the day, "we are not in it."

Let us notice a few of the things that are said to be better done in Europe, that we may for the sake of comparison see how little there is for Professor Sweet to boast of, especially when it is to be remembered that all the fine finish which we mention is put upon tools of American design and invention. "Lumber is much better sawn," we are told, "and with much less waste in nearly all other countries than here." This would be valuable information to our lumbermen, if they could only learn how it was done. Less waste of lumber, no doubt, but with great waste of time; time is the most important item of value, and where material is plentiful then material is wasted and *time saved;* this is the cause of the success of American workmen. They weigh all the elements entering into any problem and figure on how much *time* and money will be saved. The average cut of one band-saw mill I could name, per ten hours time, is 125,000 feet, board measure, of pine lumber.

"Iron-casting is a fine art in nearly all countries, except England, compared to our production," says Professor Sweet. The facts are just the other way, as was shown at the Centennial Exposition at Philadelphia. The kind of castings is not here stated, yet I can say without fear of successful contradiction that the American cooking- and heating-stoves are works of art such as are not made in Europe; such fine castings as are shown in our household hardware of all kinds are unknown to them. If there are such artistic iron molders in Europe, how is it that none of them show up in the large number of molders that emigrate to America? Is it not a fact that European mechanics in this branch have to receive instructions in our shops before they can get journeyman's wages?

"Steel castings to shape, Muntz metal, and Mitis metal are of foreign origin," we are farther told. If by steel castings to shape are meant malleable castings,—and that is all the so-called steel castings are,—then to Seth Boynton, of Newark, N. J., belongs the discovery. As for Muntz metal and Mitis metal, the terms simply mean nothing. A little more or less zinc or copper would not materially alter the structure of the so-called Muntz metal; then it might be called by some other name. The same applies to Mitis metal.

"A better built Corliss engine than was ever seen in this country was exhibited at the Paris exhibition." If we only knew what

was meant by "better built," we might be able to determine the difference. Probably highly-finished parts are meant; if so, we could take that same engine, finish it all over, and nickel-plate it *if it was required.* We have seen such engines on exhibition in America. The fact that the French put such fine finish on a Yankee engine leaves them nothing to boast of. Perseverance, and emery on a stick, in the hands of a good workman, produce a good finish, but it requires a different order of talent to invent a new type of engine.

"Machine-tools with better material, better designed, and better workmanship than the best of the American." If Professor Sweet has seen any such tools in Europe, they were, as he says, on "exhibition," and no doubt made from American designs. I have failed to see any such tools in the shops. The English machine-tools that I have seen were badly designed, badly finished, of good-enough material and workmanship, but lost in the presence of rough, ragged-edged castings. Take from their machine-tools the various time-saving devices invented by Americans, and they will have the early machine-tools of Whitworth and Maudsley. As for successful hardened and ground steel journals and boxes, I have worked on a Stewart lathe, made in New York, that had this unnecessary kind of material. The lathe was very old, but the boxes and journals showed but little wear. Other lathes with poorer material, but containing new labor- and time-saving devices, superseded this kind of tool, and it became useless except as a drill lathe.

Now as to "making a steel turret head 6″ thick and 10″ diameter, boring seven or more holes through it, and hardening the thing as hard as fire and water will make it," I can see nothing difficult in that, and I can safely say that I could go into any ordinary machine-shop having proper facilities and get an estimate on any number of them to be delivered in a given time. As this example is given to show how proficient the English, French, or Germans are in steel manipulation and risky feats of tempering, I will present an example of American skill in that line as an offset. In American tool-manufactories, where there are a large number of parts to be forged, from the smallest scissors-blank to the largest-sized tinsmith's bench-shears, no matter what the first cost of the dies may be, or how long it takes to make them,—provided they will do the work required,—they are ordered made without delay. After the largest-sized blank of a bench-shears, say 36 inches long, is

struck up between dies, there is a thin bur left around the edge, which requires to be trimmed off close to the main body. Imagine a long female die, with a punch to match it, requiring over two hundred pounds of tool steel; keep in mind the fact that this is not an iron die with steel welded on the face, such as is used in Europe. It is now required to finish and fit this pair of trimming dies, and temper them "as hard as fire and water will make them," and to draw the temper to the required degree of hardness. I have seen a pair of dies thus manipulated; when finished, the male die was laid, back down, on a planer bed, and the female die was placed over it, cutting-side down, both fitting in to about the depth required when in use, the four corners of the female die being held to a horizontal balance; when thus connected, water was thrown into the top or female die, and not one drop ran through between the upper and lower die. It will be asked how this set of dies was hardened and drawn to temper without twisting or shrinking? I would answer that nothing is left to blind chance in a shop or factory where perfection is the aim, and in this and other instances of a similar kind, the risk of cracking the female die being great, provision is made for subjecting only the cutting-edge to the chilling influence of the water, leaving the main body nearly soft. The man who made that set of dies and tempered them would regard it an easy task to make and temper the steel turret.

Exceptions might be taken to many other statements made by Professor Sweet in regard to our mechanical tools. If space permitted, it would be easy to show by documentary evidence that we have done more things in advance of precedent "than rolling tubes from the solid bar." American machinists doubtless would be pleased to learn from Professor Sweet, supposing there was no duty on European light machine-tools, whether such tools would sell here in preference to American tools? Would our machinists use them at all if made and designed as in use there? If English machine tools are superior to ours, how is it that American tools are preferred in Australia, and in many cases in England? If it is true, as stated by William Barnet Le Van, in a recent publication, in support of Professor Sweet's article, that the English locomotives are more economical and haul heavier loads with less consumption of coal, how is it that the Government of one of the Australian colonies purchased Baldwin locomotives for their railroads and found them better adapted to the work than those built in England?

There are a few other statements made by Professor Sweet which should be regarded from a historical standpoint rather than met by mere opinion as to the relative skill of different nations. T. Blanchard, of Boston, as the records show, invented and patented a lathe for turning or cutting irregular forms.* Prior to that time gun-stocks, axe-handles, shoe-lasts, and articles of an irregular form were made by hand. Now comes Professor Sweet, who tells us that "Watt invented and constructed the copying-lathe before Blanchard." If this is a fact, the records do not show it. From 1769 to 1785 Watt obtained eight patents, and it is fair to assume that if he had made such a machine it would have been of such great importance that he would have taken out a patent, for in those days the English inventors, and especially Watt, were in nowise modest in their claims. Where, then, is the evidence as to Watt's priority of invention?

"Sewing-machines," Professor Sweet says, "were an American invention and American development." Americans never have claimed to be the first inventors of the sewing-machine; it is well known that one Thomas Saint invented and actually made a sewing-machine, as described in his English patent granted July 17, 1790. [No. 1764.] "It was intended for quilting, stitching, and sewing; making shoes and other articles by means of tools and machines." It had many of the essential elements of the present machines, but was of the crudest design and construction. The French were also in the field earlier than any American. In 1830 Barthelemy Timonnier, it is stated, patented a sewing-machine in France which was so far successful that in 1841 eighty of them, made of wood, were in use for sewing army clothing at a shop in Paris. The success of Howe and other inventors of sewing-machines in America was not so much due to the inventions in themselves, as the English, French, and other workmen could at that time compete favorably with American workmen in dexterity of hand-work, and could have entered into the field of competition upon equal terms in their own countries; but just about that time the Colt's arms works had adopted a new system of duplicating, by "jigs," templets, milling and profiling machines, and drill-presses and by hand-filing, any number of interchangeable parts. This system, when applied to the intricate parts of a sewing-machine, took in a much wider range than was required for guns or pistols, and

* United States Patent No. 3008, issued March 21, 1843.

enabled our manufacturers to more fully perfect the system. To this system the success of the sewing-machine as well as all other machinery, from the locomotive to the mechanical singing-bird, is due, and to America belongs the honor of its perfection.

"Harvesting machines are supposed to be" American inventions, "but Bell invented and built mowing-machines years before McCormick," says Professor Sweet; to which it might be replied that J. Ten-Eyck, of Bridgewater, New Jersey, invented a "reaping and cutting machine" years before Bell. But I prefer to meet this invention of Bell squarely, comparing it with the grandest invention that ever was given to the human race,—the invention by Cyrus McCormick, of Steel's Tavern, Virginia, patented June 21, 1834, and July 31, 1845. I do not offer my opinion as to the merits of the reaping machines *that would not reap*, invented by the Rev. Patrick Bell and others, but will give the report of the superintendent of specifications of the English Patent Office, Bennet Woodcroft, on the exhibit of reapers and mowers at the Great Exhibition in London in 1851. It is contained in the London *Journal of Arts, Sciences and Manufactures* (Volume XI.):

> The inconvenience to which agriculturists are subjected in gathering in their cereal crops from the want of an immediate and adequate supply of reapers, when the weather is most favorable for their operation, has induced many ingenious men, during the present century, to turn their attention to the subject, with the view of substituting self-acting machinery for the sickle and the scythe. The most successful among the early attempts at reaping by mechanical means seems to have been those of Mr. Smith of Deanston (a man renowned in the annals of agriculture) and the Rev. Patrick Bell. A description of the machines invented by these gentlemen is published in the London Encyclopedia of Agriculture; from which it appears that the first trial of Smith's machine took place during the harvest of 1811, and that Mr. Bell's was publicly tested in 1828; but although fair results were in each case obtained, they were from some unexplained cause abandoned by their inventors, and were consequently lost sight of by the public. . . . . It is evident that neither the requirements of the farmer nor the prospects of reward to agricultural implement makers were sufficient to awaken public attention to the *national importance of reaping by mechanical means*. . . . . The credit of effecting this step in advance is undoubtedly due to our transatlantic brethren. . . . The first of the reaping machines which we shall notice, as contributed to the Great Exhibition, is Mr. McCormick's; this was contained in the American department, and to it a Council medal was awarded.

This short but clear statement of America's claims to the accomplishment of a task that for a century had baffled the efforts of the most eminent mechanics and inventors, with a standing reward offered by the Government and by the agricultural societies of

England before them, should close all further dispute as to who succeeded in reaping the harvest first by "mechanical means."

As to the invention of the electric telegraph, Professor Sweet says: "We are proud of Morse, and well we may be, but his great achievement was not in the invention of the electric telegraph, for that was done by others at the time or earlier; but he invented the best one. . . . The electrical part had all been preceded by Faraday and other European electricians." And why not add American electricians, also? Now at that stage of the development of electricity and the practical means of utilizing its force, the practical results then obtained were almost identical with the reaping and mowing problem when McCormick entered the field. Faraday and others had been experimenting from time to time with the electric current, and endeavoring to find some practical means of employing it. Wheatstone and Cooke were actively engaged in its practical application, and invented and patented several devices for giving alarms, and recording by means of a clock escapement indentations on paper, etc. None of these attempts was of any practical value as a telegraph transmitter and receiver until Morse (who had practically tested his invention, several years before Wheatstone and Cooke) brought out his instrument for transmitting and receiving messages through an electrified wire. Morse never claimed to be the inventor of "*the electric telegraph*," as a whole, but to him belongs the credit of being the inventor of not only the best one, but the one that would supersede all others at that time.

In this connection we may quote the conclusions reached by "Chambers' Encyclopedia" in support of Fulton's claims to the invention of the first steam-propelled vessel, as it covers the case of Morse and many others:

> We do not consider it of the least moment to mention how or by whom steam-propulsion was first discovered; the merit of this and every other great invention is alone due to the person who brought it into practical use, and in the present instance it is clear that that person was Fulton.

The reader will see that in the treatment of this subject I have given good English authority for my statements as to priority of invention in the cases cited. In the conclusion of his article Professor Sweet says: "There are no doubt scores of things better done abroad than here, or not done at all here, that I have not mentioned." The omission of those several *scores* of things done abroad that are not done here is very unfortunate, as the bare

names of them without a detailed description would be of great value to our manufacturers. "Is not cultivating the notion that we can learn nothing from other nations detrimental to progress? Is not boasting in every form bad taste?" These are the concluding sentences of Professor Sweet, and in concluding I will answer: "Cultivating the notion" that Americans *are* learning nothing from other nations shows only an error of judgment.

ELECTRICITY.

Conducted by Franklin L. Pope.

THE opening of long-distance telephone service between New York and Chicago is a remarkable event in the history of electrical intercommunication. The line is a double metallic circuit of hard-drawn copper wire, 950 miles in length and weighing 826,500 pounds. The poles are 35 feet long and 42,750 in number. The tariff which has been established, $9 for five minutes' conversation, will seem rather steep to the uninitiated, but it must not be forgotten that, with the improved telegraphic apparatus now used, such a pair of wires might be made to earn a good deal more than $2 per minute during six or eight hours of every business day. No doubt the telephone will find full occupation between these cities as soon as its advantages are fully appreciated.

THE annual report of the Western Union Telegraph Company gives figures which show a continuous and healthy growth of this great system of intercommunication. The company now controls 739,105 miles of wire and 20,700 stations, and received during the fiscal year $23,706,404.72 for transmitting 62,387,298 messages. For seven years past there has been but a trifling variation either in the average tolls received per message or in the average cost to the company of handling them, the gross receipts averaging 31.5 cents and the cost 22.9 cents per message. It would be hard to mention a business which has established itself on a firmer basis of enduring prosperity than has the telegraphic service. We have often thought, however, that in a business in which the cost of operation is so vitally influenced by the zealous coöperation of each individual employé, if some equitable form of profit-sharing could be devised and put in operation, it would tend to exert a marked influence, not only on the general efficiency of the service, but on the profits of the company. An increase even of five per cent. in the earning capacity of a plant costing well toward one hundred million dollars would make a tidy sum, and we believe it would be quite possible to realize even a higher figure than this under the conditions suggested. This would seem to be one of the few kinds of business in which it would be safe to make an experiment of this kind, as the vexed question of sharing the losses as well as profits is not likely to turn up.

AT a recent meeting of the American Street Railway Association a report was presented from a committee which had been appointed to ascertain the relative cost of operation of horse, cable, and electric street-railways. A comparison of a typical cable with a typical electric line, of about the same capacity and located in the same city, gave some interesting, though perhaps not wholly conclusive, figures. Comparing cost of construction with returns, it appeared that each dollar invested in the electric road earned more than a dollar invested in the cable road in the ratio of 4 to 3. It appeared furthermore that 89 per cent. of the electric roads reporting had earned dividends of from 5 to 12 per cent,—certainly a very encouraging showing. It is certain that the electric systems are far from having reached a condition of maximum economic efficiency, and if this be so, the universal adoption of the electric system is likely to be a mere matter of time.

PROFESSOR LUCIEN J. BLAKE, of the University of Kansas, in an address before an association of Fire Underwriters, made some forcible observations respecting the character of too much of the electric wiring of the present day, pointing out that almost without exception the chief dan-

gers from the use of electric wires have been found to be due to the employment of incompetent, underpaid, and conscienceless workmen. Some construction companies have adopted the vicious practice of paying a workman so much per lamp wired, making his earnings depend upon the rapidity, and not upon the quality, of his work. Others do not scruple to employ anybody, whether competent or not, if he can only be hired cheap enough. A step in the right direction, Professor Blake thinks, would be to require every workman to be licensed by a proper board after due examination, which, although it could not necessarily insure honest work, would at least prevent ignorance. How to secure skilful and conscientious work in electric wiring is indeed a most difficult problem, but it is one which must by some means be met and solved. A cordial and intelligent coöperation between the underwriters and the Institute of Electrical Engineers in respect to this reform might easily be brought about, and could not but result in much good.

THE Salmon Falls (N. H.) Manufacturing Co. have 2100 feet of railway track in their mill-yard, and employ a trolley system of electric cars to move all their coal, cotton, supplies, and cloth, thereby dispensing with the services of a team and three or four men. Two men are able to manage the entire installation, which is run by water-power.

A CONSIDERABLE portion of the electric light and power used in Hartford, Conn., is brought from a water-power at Tariffville, ten miles distant. The total amount thus transmitted and distributed is about 300 horse power.

PROFESSOR E. L. NICHOLS, of Cornell University, has made a study of the effects of what he terms the "age-coating," commonly called the "blackening," of incandescent lamps. He finds that the rate of deposit upon the inside of the bulb is most rapid in the early part of the life of the lamp, and that the loss of brightness is greatest in lamps of high initial efficiency. He found no marked difference between the character of the deposit from treated and from non-treated filaments.

THE "Standard Electrical Dictionary," a handy duodecimo volume of 625 pages, prepared by T. O'Connor Sloane, has been issued by N. W. Henley & Co., of New York. The definitions are sufficiently full and appear to be unusually concise and accurate. Great pains seem to have been taken to avoid unnecessary repetitions, and the innumerable cross-references which have constituted such an objection in some works of this kind have been judiciously dispensed with, their necessity being avoided by the insertion of an adequate index. No electrician can afford to be without a work of this kind, and the present one seems admirably adapted to meet the requirements of the profession.

IT is announced that it has been definitely determined to equip the Second-avenue line in New York city with a storage battery-system. Ten cars are to be put in active service at an early day, followed by others as rapidly as possible.

THE managers of the New York Electrical Society have arranged for a very interesting course of lectures the coming winter, most of which are of an unusually practical character. The programme and dates of the lectures will be announced in the electrical journals. Admission may be had on presentation of non-transferable tickets, which may be obtained gratuitously of the Secretary.

THE new central station of the Allegheny County Light Co., of Pittsburg, now just about completed, is one of the largest in the country. It will have an ultimate capacity of 125,000 16-candle incandescent lamps. All the appliances are to be of the most modern and approved types.

A NEW fire- and water-proof insulated wire has been put on the market, which is not only absolutely non-combustible, but which has shown a very high insulation

resistance after ten days' immersion in water at a temperature of 80°.

ONE of the street-car lines of Bremen, Germany, has been for some months operated by an American overhead trolley electric system, which has given such satisfaction that it has now been determined to extend it to all the lines in the city.

THE new Westinghouse incandescent lamp, which has just made its appearance on the market, exhibits several features of considerable novelty. It will be remembered that the characteristic feature of the Edison lamp is the hermetical sealing by fusion of platinum leading-in wires into the walls of an exhausted glass globe containing the carbon burner. In the Westinghouse lamp the mouth of the globe is closed by a removable stopper of cast glass, capable of forming an air-tight joint not only with the leading-in wires, but with the glass of the globe. This construction not only admits of the cheap and easy replacement of the carbon without injury to the globe, but makes it possible to employ iron leading-in wires instead of the much more costly platinum wires hitherto used. If, as seems probable, a large reduction in the cost of lamps is thus rendered possible, they can be run at a much higher efficiency, and an important reduction made in the cost of operation of electric-lighting plants. It has for some time been apparent that we must look to improvements in the lamps for any considerable reduction in the present cost of domestic electric lighting, and hence every invention of this character will be hailed with delight by the central-station manager, who too often has about all he can do, under existing conditions, to make his strap and buckle meet.

IN operating street-railway plants by electricity generated by water-power the excessive variations of load unavoidable in such service have rendered the problem of efficiently regulating the generating power an extremely perplexing one. The inertia and incompressibility of water render it impossible to control the flow with sufficient promptness to follow closely the sudden changes of load. In a street railway plant at Oswego, N. Y., this difficulty seems to have been met quite successfully by the use of an artificial resistance of iron wire of a capacity nearly equal to the maximum output of the generators. This makes a compensation which may be automatically varied, so as to maintain a constant load on the generators, notwithstanding the fluctuations of the live load. Of course the objection to this plan lies in the fact that there is a steady maximum load on the water-wheels all the time, but if the supply of water is not limited, as is often the case in such plants, it is not a very serious one.

THE cars of the West End Street railway of Boston are to be equipped with an automatic safety fender, which has been approved by the Massachusetts Railroad Commissioners after a series of experiments extending over a year. The fender is a movable platform, so arranged that the turning of the brake-handle first applies the brake, and then almost simultaneously lowers the fender down to the track in front of the car. The operation of this device has been found to ensure practical immunity from injury to a body lying upon the track, while it imposes no additional attention or responsibility upon the driver of the car.

IT is announced that a company has been incorporated to construct an electric railway and "boulevard" between Baltimore and Washington, a distance of about forty miles, upon which trains are to be run at the rate of 60 miles per hour, at a fare of 25 cents. As it costs a steam-railway something like a cent per mile to carry passengers at the rate mentioned, it is not easy to see at a glance how an electric railway can charge passengers half that figure and make money. The conditions are totally unlike those of a street-railway line having a large traffic of short distance passengers; and, while there are doubtless many steam-railways now in operation upon which the service might be more efficiently and economically performed by

electricity, we should scarcely look for such a result in the sparsely settled and not especially attractive wilderness that separates the termini of the proposed line.

A NEW iron steam-lightship designed to be stationed off Cornfield Point in Long Island Sound has been fitted with a dynamo and incandescent lamp plant. The entire equipment is in duplicate. The mast-head lights comprise eight 100 candle-power lamps, four on each mast. The power is furnished by two dynamos,—each driven by an 8 horse-power engine,—which are used in alternation. Instead of employing a heavy revolving lens to exhibit flashes, the same effect is produced by an automatically controlled circuit-breaker placed in the dynamo room. The ship is capable of steaming at the rate of nine knots per hour, and of taking care of itself in case it breaks adrift in a storm.

MR. J. W. SWAN, a well known investigator in the realms of electricity and light, in a discourse before the Royal Institution, has called attention to the enormous improvement which has been effected in the capacity of copper for conducting the electric current since the time of the laying of the first Atlantic cable in 1858. As a conductor, one ton of the copper of to-day will do the work of two-and-a-half tons of the best metal obtainable in 1858. This change is largely due to the improved modern methods of refining by electrolytic processes.

THE united capacity of all the plants now in operation in the world for refining copper by electrolysis amounts to nearly 100 tons of copper deposited per day of twenty-four hours. This result has only been rendered possible by the development of the modern dynamo.

THE Narragansett Electric Light Co., of Providence, R. I., is credited with having one of the best equipped and most skilfully managed central stations in the country. A new generator just installed by it is of a unique type. It weighs sixty tons, and gives 7200 alternations at ninety revolutions per minute. It is coupled direct to a 500 horse-power horizontal compound engine of 48-inch stroke. The machine embodies many new and interesting features, and its performance will be watched with interest. Another generator of equal capacity but of different construction is being erected in the same station by another maker.

AN interesting incident of the opening of the long-distance telephone line between New York and Chicago was a conversation held between Professor Bell in New York and Mr. William H. Hubbard in Chicago. Mr. Hubbard assisted Professor Bell at the very first public exhibition of the telephone at the Centennial Exhibition in 1876, and it is said that the two have not conversed by wire since that time.

THE preconceived notions of the behavior of railway track rails under variations of temperature appear to have been somewhat upset by the results of the experiments of Mr. Philip Noonan, reported at the Cleveland street-railway convention. It is now possible, by means of electric welding, to lay down rails in a continuous piece, without joints, for any length; and Mr. Noonan's investigations seem to show that, although the temperature of the rail closely follows that of the air, notwithstanding it may be embedded in earth, in 1160 feet of rail closely wedged together there was absolutely no displacement of the track within a range of temperature of no less than 121°. There seems to be reason to believe that the expansion is taken up by a minute enlargement of the sectional area of the rail. If there is no error in these results, their importance can scarcely be overrated. No greater improvement in track-construction could be imagined than that which would follow from the entire abolition of joints. They are at once the weakest and most costly portion of the structure, and entail literally endless trouble in keeping them in order.

A CURSORY examination of the price-lists of manufacturers of electrical apparatus in England shows that last year there

were on the market no less than 249 different sizes and types of direct-current dynamos.

IT was anticipated, and not without reason, that the electrical illuminations exhibited in New York during the recent Columbus celebration would surpass anything of the kind heretofore attempted, but a strict regard for the truth compels the expression of an opinion that as a whole it was little better than a gigantic failure. There were, it is true, some meritorious examples of electric illumination in the way of buildings, such as the Edison building on Broad St., and the New York Life Insurance building on Broadway, but the illumination of the floats in the night "pageant," at least as seen by an observer at Union Square, can only be fittingly characterized as a ghastly disappointment.

AN electrical genius in London has opened the way for a new industry, which, in that locality at least, would seem to be fraught with the most alarming possibilities. The writer once upon a time waited a long while in the cold in a line which had been formed for a free view of the moon through the telescope of a peripatetic curbstone astronomer on lower Broadway, and was rewarded for his patience by beholding a vast illuminated disk bearing the inscription: "Try ——'s Sarsaparilla, Ten Doses for a Dollar." But our transatlantic friend has a trick worth two of this. He projects his advertisements upon the nether surface of the murky firmament of the British metropolis, and his experiments have been, to quote the *Daily Telegraph*, "deplorably successful." "Our only hope," says the *Globe*, "is that if the practice of advertising in the heavens should become common, the rival advertisers will make such a hotch-potch of each other's announcements that they will all have to give up in despair." As the British real-estate owner is proverbially tenacious of his proprietary rights, which from a legal point of view undoubtedly extend to, if not beyond, the zenith, we shall doubtless soon be entertained with litigation growing out of the encroachments upon each other's territories of these disfigurers of the empyrean.

DURING the past summer the streets of Albany have been sprinkled by an electrically propelled watering-cart in the form of a huge iron tank made in the semblance of a street-car, running upon the track and receiving its power from the trolley-wire in the usual way.

IN a communication to the *Electrical Engineer* Dr. Paul Schoop gives some interesting facts relative to the use of the storage battery in electric lighting in Germany. The type of battery most used is that known as the "Tudor," the essential feature of which is a cast grooved plate of lead provided first with an active layer according to the Planté process, which is supplemented by a pasted layer applied by the process patented in this country by Brush. This layer falls out of the grooves after the battery has been some time in use, and is so calculated that the Planté layer formed during that time is just sufficient to provide thereafter for the entire storage capacity of the plate. A cell of 500 ampere hours capacity, capable of discharging at the rate of 110 amperes, is sold for about $30. The Tudor plates are said to stand the service required in electric lighting remarkably well, some millions of them being now in practical use. A single establishment in Germany has sold during the past two years batteries to the value of $2,250,000. One of the larger stations, that at Dusseldorf, utilizes 840 cells, with a capacity of 2,300,000 watt-hours, and another at Breslau has nearly as many, not to mention numerous others of lesser capacity. It is much to be regretted that so serviceable a type of battery as this appears to be cannot be introduced in the United States. The condition of affairs in this country is certainly unfortunate in the respect that the company holding the controlling patents seems to have been for some reason peculiarly unsuccessful in producing a practically useful battery, or at least one which our electricians are willing to accept as such.

MECHANICS

Conducted by Frederic R. Hutton.

THE non-technical observer sometimes asks why advanced modern practise in steam-engineering favors the use of more than one cylinder in the new engines as he sees them in marine, electric-lighting, or pumping plants. The most concise answer to the question is that the object is to save coal by using a high degree of expansion of the steam which works in the cylinders. This means that the steam which enters the engine from the boiler shall have a pressure very much higher than that which it has when it leaves the engine, so that all practicable, available heat and force for doing the work shall have been abstracted from it before it leaves the contact with the working piston. If the steam leaves the cylinder unnecessarily hot, it carries with it to waste heat which should have been utilized in doing work, and which has been given to the steam by the coal burned under the boiler, which costs money. It becomes of interest to the engineer to separate as widely as possible the initial and final pressures and temperatures of the steam which he uses, and to have the latter or final temperature as low as it can be made. It is desirable therefore to have the steam escape from the engine into a chamber within which the pressures shall be less than those represented by the pressure of the atmosphere, inasmuch as under atmospheric pressure steam cannot remain a vapor at a temperature lower than 212° F., and if the engineer seeks to get a lower terminal pressure than this, it must be had by means of exhausting the steam into a vacuum, within which, practise shows, a temperature of about 100° F. can be maintained by the process of condensation and cooling with large quantities of cold water. This inferior limit is fixed for both temperature and pressure, and cannot be much exceeded without its costing more than it comes to.

The only way to increase the space intervening between the terminal pressure and the initial pressure when the steam enters the cylinder is to raise the temperature and pressure of the steam carried in the boiler. This explains why the pressures carried in all modern plants have been so steadily rising beyond the limits fixed by earlier practise. The lowering of the pressure and temperature of a gas such as engine-steam is to be attained by greatly increasing its volume while it is doing its work. Therefore in a cylinder of a given volume there must be admitted only a small fraction of its volume of high-pressure steam behind the piston, in order that at the end of its stroke the terminal pressure and temperature shall be reasonably near the inferior limit noted above.

There would therefore be an enormous pressure of steam upon the piston-area at the beginning of the stroke, when the turning effort of a crank was very small, if the entire driving work were to be done in one cylinder. If more than one cylinder is used, the volume increasing as the steam passes from cylinder to cylinder, it will be seen that the same expansion can be secured, and the steam fill a much greater volume in the first or small cylinder, acting by so much the more favorably to produce rotation of the shaft to be driven. This mechanical advantage favors again the efficient use of the steam which enters the engine, which again favors the economy and the coal-saving.

THE preceding paragraph may be compared to a calculation made in round numbers to express why the condensing-engine is better than that which exhausts its steam into the open air without condensation, and why the compound- or multiple-expansion engine has found the favor which it has won. It will be recog-

nized that it does not take account of certain incidental advantages, nor does it concern itself with certain refinements. There is a gain in the many-cylinder engine from the distribution of the effort of the steam over more than one crank-pin, by which a concentration of strain is avoided, and by which rotative effort is equalized throughout a revolution of the engine-shaft, so that either a lighter fly-wheel is made possible, or better regulation secured with a fly-wheel of a given weight.

In marine practise, where a turning propeller, which is the resistance of the engine, may occasionally be partly or wholly out of water, the presence of the reciprocating mass beyond the first cylinder has a restraining effect to prevent too sudden applications of immense power against greatly diminished resistance.

Furthermore, by distributing the range of temperature in several cylinders, instead of permitting it to be concentrated in one, the interchange of heat and cooling from the cylinder walls to the vapor within them is retarded by virtue of the principle that the amount of heat transferred in a given time depends upon the difference between the temperatures of the two bodies which are acting upon each other. The hottest steam in the multiple engine never reaches the coolest cylinder, and there is therefore a practical gain from this source.

THE increasing pressures imposed upon marine boilers by the increasing temperatures exacted for the incoming steam in the many cylinder engines have compelled the designers of marine boilers to make use of forms of special strength to resist the increasing strains. The marine boiler, as a rule of necessity, is one in which the fire which is the source of heat is internal to the water to be evaporated.

Engineers call such boilers "internally-fired boilers." The fire-boxes, being surrounded by water and thereby kept relatively cool, must be of comparatively large volume in order that combustion may be perfect within them, since, if the surfaces cooled by water are too close upon the top of the fire, the fire cannot be kept at a temperature high enough to secure perfect combustion of the carbon-gas which is given off. Hence the necessity for the use in such boilers of flues of large diameters. But in a flue of large diameter, exposed to an exterior pressure tending to collapse it, the danger of such collapse increases with the diameter; and where great areas of heating surfaces are called for, boiler-makers have been faced for many years with the necessity of stiffening such flues against such collapse.

The English methods of attaining this end in the past have been the use of stiffening rings around the outside of the flue and within the water. Either these rings were of some rolled shape such as an angle or a "T" iron, or else the joint between the consecutive rings of the flue-plate was made by a U-shaped ring of plate secured to the contiguous plates of the flue in the usual manner. The most successful of the modern methods of securing strength of flues against collapse is the corrugated flue, which, while not novel in idea,—inasmuch as it was patented in 1852 by Richard Montgomery,—has yet had to wait until the development of machinery made its production on a commercial scale possible.

As usually made, the flue-plate is curved to a cylinder and welded at the longitudinal joint, and the welded cylinder is then put into corrugating rolls, by which the corrugations are developed. This procedure has also the effect of subjecting the welded seam to a type of strain which thoroughly tests the perfection of the welded joint, since it is the uncertainty with regard to the weld which is the critical source of opposition to the welded seam on the part of conservative designers. A riveted seam can be inspected in each successive state of its formation; the perfection of the weld must be more or less dependent upon the manufacturer.

The usual design of corrugated furnace in this country has a distance of six inches between the peaks of the corrugations and a total depth of two inches. An interesting model can be made to show the very notable increase in the vertical or

collapsing strength of a corrugated tube as compared with a straight one by taking two pieces of fine brass tube of equal thickness for the two illustrations, and comparing the deformation resistance of the two. The plain tube, two inches in diameter, can be compressed decidedly out of the cylindrical shape by the pressure between the fingers and thumb. A corrugated tube of the same metal subjected to the weight of a full-sized man will show a deformation only just visible to the eye. These corrugated furnaces will be found in the great majority of marine boilers designed for the navy, or transatlantic service.

THE wood-working tool called the band-saw has been recognized for many years as a very distinct improvement upon the old-fashioned reciprocating- or jig-saw for the production of curved outlines in patterns and other similar shop-work. It has the advantage of continuous motion, and a high cutting-speed by reason of that continuous motion, but of course is subject to the limitations which do not attach to the jig-saw,—that is, it cannot, by reason of its continuity, do work upon the inside curves of such designs as have a continuous boundary. One of the critical points in the satisfactory working of a band-saw is the device used to withstand the thrust which the feeding of the wood exerts against the edge of the blade to deflect it. There have been a number of devices in use for accomplishing this purpose, such as a set of balls or a plane plate or a roller, but the most satisfactory have been in the form of simple disks whose plane the path of the saw back should intersect as a chord. By this means the disk was revolved by the saw, but the discoidal motion of the saw coming at an infinity of angles with the diameters of the disk precludes its being worn into grooves. A very recent form of this device uses a roller which is in the shape of a frustum of a cone, the saw-blade bearing against the surface elements of the cone, but at an angle with them; the discoidal effect is produced as in the disk, but the reacting pressure is brought much nearer to the working point of the saw-blade. There are a number of points of convenience in the attachment as proposed, both as to its application and its adjustment.

IT is scarcely safe for a writer in a monthly periodical to give a record of the latest transatlantic performance, inasmuch as the probability is great that a reliable report of its eclipse will reach the public before his comments get into print. This time it is the *City of Paris*, of the Inman and International Line, and the record is reported as five days, fourteen hours, and twenty-four minutes, from Queenstown to Sandy Hook. This means that, leaving the Mersey early in the morning of Thursday, October 13, she was at Sandy Hook on the morning of Wednesday, October 19, making the total time of six days and two-and-a-half hours, including the time necessary for calling at Queenstown. Her best day's record was 530 knots, which is the longest distance at this date which has been steamed on one day. This is an hour and thirty-four minutes less than her own best time heretofore, which makes the passage one of considerable interest to all engineers.

This performance gives special interest to the announcement that the owners of the *City of Paris* and the *City of New York* have placed orders, or are to place them, with the ship-building firm of Messrs. Cramp of Philadelphia for the building of four transatlantic steamships, the conditions of whose acceptance are that they shall surpass in tonnage and speed the best products of the British yards. This succession of events gives special interest to an article in the *North American Review* from the pen of one of the Messrs. Cramp, calling attention to the dwindling, during the last decade, of the disparity of cost on this side of the water, and on the other, between the vessels and their equipment, expressed in the unit of ton for ton, or gun for gun, in the two cases. He calls attention to the fact that in the case of three latest battle-ships the margin between the United States and the British prices is to be expressed by a very small figure. This, of course, is attributable to the develop-

ment in this country of shops and yards fitted with the best modern machinery, both for handling and operating upon marine work, by which the efficient high-priced American labor approaches more nearly the actual cost of the less highly paid but more multitudinous foreign labor unassisted by the new machinery.

THE sanitary engineer very often has to call to his help the capacity of the mechanical engineer to meet the problems which are imposed upon him in districts where the ground is so flat that the disposal of sewage cannot be effected by gravity alone acting upon the material in a sloping channel. One of the best and most impressive illustrations of this state of affairs is the example in Boston, Mass., where provision has had to be made, due to the conditions of level, for the pumping of the sewage into receiving tanks, on an island some distance out in the harbor, from which it can be allowed to flow out upon the ebb of the tide. The pumps for this well-known plant are one of the monuments which have been erected by one of the best-known mechanical engineers of America, Mr. E. D. Leavitt, past-president of the American Society of Mechanical Engineers.

In circumstances where a plant of this magnitude is not possible or judicious, the problem of accomplishing the same result is often before the engineer. There is reported in London *Engineering* a method for raising a small amount of sewage without using steam-power, if there should happen to be present in the topography of the district a hill furnishing from its elevation a fall which it is possible to utilize for power purposes. At a convenient point in the system the sewage from the high level is made to run into a closed iron receptacle and, in so doing, to compress the air already in it. This receptacle is connected by a pipe with one in the low level district into which its sewage has been accumulated until it is full. The pressure of the air from the first vessel forces the sewage out of the second vessel up through a rising main to a level from which it can be drawn off by gravity, either into a flowing river or a precipitation tank; self-acting valves fill and empty each one alternately; and the apparatus, if arranged in duplicate, can give a constant discharge. It would appear that where suitable precautions were taken to prevent back pressure from the receptacles, and where other conditions were suitable, this method ought to prove both efficient and economical.

FROM English sources a new form of pulsating electric rock-drill is presented to the engineer, differing in principle from the solenoid drill, which has been a favorite form. The drill is pulsated by a cam being driven through a worm and wheel from the armature of a motor borne upon the carriage which attaches itself to the usual posts for use in headings. The motor runs at 1800 revolutions per minute with a current of ten amperes at one hundred volts, and the bit makes 230 to 240 blows per minute with a force equivalent to a weight of 360 pounds upon it. The criticism to be offered against the arrangement would appear to be that which attaches itself to the use of a cam under these circumstances with its liability to rapid and annoying wear. When constructed on the solenoid plan, where there is no wearing surface, this trouble would not exist. The plan seemed to work well in the experimental rock upon which it was tried.

A RECENT improvement in the drop cams of a silver or gold ore stamp mill consists in doubling the cams, so that they shall act upon the tappet of the drop alternately on its right and left side, and thereby produce upon it an alternating revolving motion, instead of the continuous motion in one direction which follows when a single cam is used. By this expedient also the thrust is diminished upon the cam shaft, so that it runs more nearly balanced from the endwise thrust between its collars, and the stamps tend to wear the dies more evenly by diminishing the tendency to cause them to fall to one side rather than the other. The ore is not so likely to silt more to one part of the mortar box than to others.

IT will be recalled that in September attention was directed in this department to a device for the boring of polygonal holes. The square hole is the one most generally interesting, although the tool referred to will bore more shapes than one. A correspondent from New England has requested further details as to the device, and has brought up the question whether the square hole is really a geometric figure, or whether it is a four-sided opening with rounded corners, the rounded corners being struck with a radius equal to that of the revolving cutter. The writer speaks of his knowledge that many attempts have been made to bore such a square hole, but that he has been unable so far to trace any successes in this direction. The Department of Mechanics, feeling that chapter and verse would be the most satisfactory answer to this question, has consulted with Mr. A. D. Pentz, who conducts the Department of Machine-Shop Notes, and who is an expert in the particular class of work concerning which the correspondent makes inquiry. The statement of Mr. Pentz is given herewith, with diagrams.

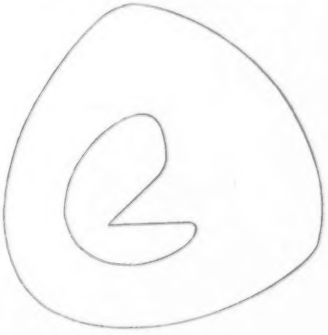


FIG. 1.

The most satisfactory conviction of the operation can be derived from cutting out a card the shape of Figure 1, and laying it in all positions upon Figure 2. It will thus be seen that the hole which results will be one with real square corners, as in Figure 3. Mr. Pentz says:

"My familiarity with the square-hole problem dates back fifteen years, although I was before that aware that a drill having three lips and a cross section bounded by

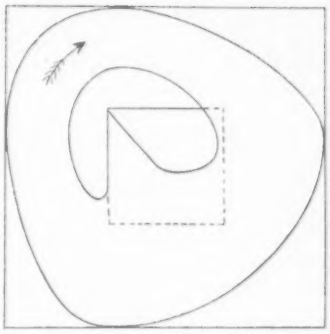


FIG. 2.

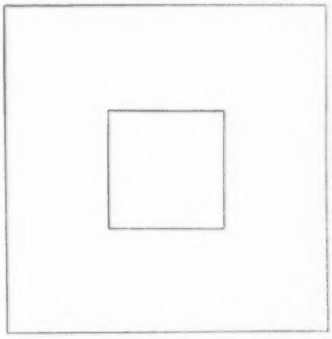


FIG. 3.

three similar arcs of 60° would, within a square bushing, drill a square hole having round corners of a radius equal to the versed sine of one of these arcs. This device was exhibited many years ago,—perhaps fifteen,—and it was reported by Park Benjamin, I believe. It was a shop trick, however, many years before that. In 1877, experimenting with the feed cam of a Singer sewing machine, I found that if it were turned within a square hole one of its construction points described an exact square with angular corners. The trouble with the device is that it takes a different device to drill each size of hole. In 1886 I formulated the data of this cam, which I published just one year ago in the *Scientific American* running through three issues. I have seen notices of at least two English machines to drill square holes. The means they use, I think, is the same as I have described. It was shown in the technical journals of the period how the job was done."

ARCHITECTURE.

Conducted by Barr Ferree.

IT is characteristic of civilization that the newer communities are better off than older ones in being provided with the most approved and advanced appliances. It is positively startling to enter a little mining camp in Colorado and find it brilliantly illuminated with electric lights. It is the proud boast of the people of Denver that their great new city contains not a single horse-car, the motive power being cable or electricity. But the progress of the western cities is shown in their buildings as well as in means of transportation and methods of illumination. Cities of but yesterday, in the far West, are provided with the most improved office buildings, gigantic structures which it has taken Eastern cities two hundred years or more to reach. It is true, this is the form of building now practised in business architecture, and a new business building anywhere, to be up with the times, must be in this style. But it is nevertheless startling to run up against great office buildings, with numerous elevators, with every other possible convenience and improvement which one is accustomed to look upon as the exclusive product of the East. It forces in upon one the inherent progressiveness of the far West to see that a region which but a few years ago was an unbroken wilderness, or occupied only by the roughest settlers, is to-day dotted with rich cities abounding in magnificent and costly buildings, as thoroughly advanced and as typical of metropolitan life as the greatest

THE EQUITABLE BUILDING, DENVER, COLORADO.

[Andrews, Jaques & Rantoul, Architects.]

buildings of New York and Boston. It is unmistakable proof of the vast wealth of this country that the new cities have arisen in so short a period of time, and have become at once real cities with every evidence of greatness. Athene springing fully armed from the head of Zeus was not a greater phenomenon than the cities of western America that have developed into maturity in less than a generation. They are not yet complete, all their buildings are not yet of the most perfect modern form, but their largest and most pretentious structures are fully the equal of similar buildings in the East. Sometimes they surpass them.

An example of this advanced type is the Equitable Building at Denver. Designed by a Boston firm of architects, Messrs. Andrews, Jaques & Rantoul, it expresses more completely the conditions imposed on modern business buildings in great cities, and their proper architectural interpretation, than, perhaps, any other similar edifice in the country. The plan is the key to the whole. The most difficult part of designing large buildings is the lighting. The interior court, which has long been a favorite device, is now being abandoned by the better architects, and the peculiar form of the façade of the Equitable Building is due to the employment of four external courts, two on each face, dividing the structure above the second floor into two wings and a central pavilion. The latter feature is cut off at the angles, giving greater light to the courts while scarcely injuring the renting value of the rooms it affects. This arrangement gives twelve corner suites of offices to each of the upper floors, a most unusual thing in a building of this size, while every room has light and air from the exterior. The design loses something by being broken up in this manner, but the briefest study of the plan makes the reason of it so evident, and it is so eminently useful and necessary withal, that only admiration can be felt for the ingenious way in which the greatest possible utility has been obtained. But the merits of the exterior do not cease with the plan. The ample exterior courts would lose much of their value had the walls been built of a dark material. It may readily be supposed that the architects who devised this very ingenious plan would not commit this error. The basement of the building, which runs through two stories, is built of a light pinkish Colorado granite; the remainder of the exterior is throughout a white enameled brick, of high reflective power, so

EQUITABLE BUILDING, DENVER, COLORADO—PLAN, THIRD FLOOR.

that the interior rooms receive the greatest possible amount of light. Thus in both materials and plan every effort has been made to obtain the most desirable rooms from the site. The architecture of the building, if such a term be applicable to its external form and decorative parts, has been subordinated to the conditions imposed by the necessity of obtaining the greatest renting value from the land. It is hard to imagine a more satisfactory or better solution to the problem. Notwithstanding its many admirable features, the building is not without its faults. The most important of these is the way in which it is cut up into rooms, nearly all of which communicate with each other. A central corridor divides it into halves, and on some floors it is possible to pass from one end to the other through the rooms without making use of the corridor at all. Strictly speaking, each floor consists of six great suites of offices in which ample and free communication is eminently necessary. Doubtless, if all of these are rented together, no objection can be raised, but in its unoccupied form, and considered as a plan alone, it is an unnecessary evil to make all the rooms connecting. It is an error not confined to this structure, but the generality of a usage does not excuse a fault.

CAN one imagine a hundred or more sensible, cultured, active men of affairs rushing to Vesuvius at the time of an eruption, descending into the burning crater, and there seriously and carefully discussing their business, its wants and needs, its progress and deficiencies? Can one talk business or think business in mid-ocean during a terrific storm when one's whole mind and body are concerned with one's physical, perhaps with one's spiritual, welfare? Preposterous as such questions are, they are not more preposterous than was the action of the American Institute of Architects in holding its annual convention in Chicago at the precise time when the World's Fair buildings were being dedicated. The Institute has not always been happy in the time of its meetings, but this year it was so extremely unfortunate that the date and place would have been grotesque had they not been deliberately selected months in advance. It is hard to tell so eminent a body of professional men that they should have known better than to meet under these circumstances, —that their action appears more like a scheme to cover the poverty of their sessions than an honest attempt to be mutually benefited by discussions and interchange of ideas. Yet it must be confessed that, when the leading architectural body of America thus seeks to hide itself from the public eye, and of all places selects that portion of America which is most crowded and most concerned with other things than their doings, one cannot but feel how much better less able, less well equipped, less cultured bodies of men do when holding professional meetings. The records of the Real Estate convention the month before in Buffalo, with its pyrotechnic accompaniment of Colonel Ingersoll and Mr. George, did vastly better, while the records of many a lesser organization teem with rich and valuable discussions which were quite wanting in this last meeting of the Institute of Architects. Of course the Fair dedication was the attraction, but it would have been better to have organized a special excursion for that purpose than to have given up the annual meeting to a taking part in processions, to an eating of luncheons, and an almost complete ignoring of the serious purposes of professional talk. The real purposes of the convention were saved from utter collapse by the courage and persistency of one architect, Mr. Frederick Baumann, who presented the single paper of the session, entitled "Thoughts on Style." The whole record of architectural meetings, at home or abroad, does not equal this in paucity of material or lack of real business and aggressive interest, and it is the more astonishing since the membership of the Institute includes not only the foremost members of the profession, but many of the most active men of affairs in any walk of life. They know, as every one knows, that the last meeting, as a professional meeting, was a farce. The Institute must do better than this,—and it need

not go without its own membership to do it,—or it will fall into contempt with the public which it neither deserves nor merits.

In striking contrast to the literary desolation presented by the Institute are the Transactions of the Seventh International Congress of Hygiene and Demography held in London last year, and which are now being printed in book form.* An international organization drawing upon the entire world for its material, the deliberations of this body may well serve as a model for similar assemblies in kindred branches. The volumes containing the papers and discussions in the sections on Architecture and Engineering, with which the readers of this Magazine will be mostly interested, contain much valuable matter, and summarize in a convenient and accessible form the latest results in both these sciences so far as they relate to hygiene. And from the sanitary and hygienic standpoint there is a closer union between architecture and engineering than exists in any other phase of these now much connected sciences. Here, at all events, the architect and the engineer can find much that is helpful for each other, and, however wide apart their work may be in other fields, only a great economic waste can come from their separation in this. It would require more than a single paragraph to quote but the titles of the more important papers contained in these well printed, though not large, volumes. In architecture special reference should be made to the exceedingly interesting discussion of "Some Insanitary Superstitions in House Building," by H. H. Statham, which every housewife, as well as every builder, will find of practical value. Several papers are concerned with that never dying problem, the housing of the poor, and sanitary dwellings for the working classes, while drains, open spaces, sanitary walls, steam in cities, and other not less important topics come in for careful treatment. Engineering, sewage, drainage, ventilation, water supply, purification of water, and similar topics, many of which have a direct architectural value, are ably treated by some of the highest authorities in the world. When one has before him the record of such satisfactory work, one realizes completely how valuable to all concerned, and to those who have access to the printed records, a congress such as this can be. It is sincerely to be trusted that the similar congresses which will be held in Chicago next year will be equally rich in results, equally satisfactory to the professional student and general reader alike.

The Milwaukee fire, though a serious thing for the people directly affected, is not in the least comparable to the great Chicago fire of 1871, or the lesser catastrophe which befell the city of Boston a few years later. Generally speaking, Milwaukee is a city of wood. The new business architecture has only made a beginning in it; apart from its gigantic breweries and a half dozen new office buildings it contains little of real architectural interest, and even the breweries are more impressive by their size than by any architectural or building characteristics. Viewed from any high place the city is a wooden city, the prevailing grey of the walls and the dark slate of the roofs contrasting oddly with the trees which line every street and give this busy, active metropolis of Wisconsin more the air of a suburban town than that of a great and growing city. The recent fire had flimsy materials to deal with, but by great good fortune it was confined to the worst part of the city, which, before long, would have required rebuilding in order to continue profitable to its owners. Any conflagration which throws three hundred people out of their homes and destroys upwards of $3,000,000 worth of property is not to be viewed as a trifle; yet its ultimate results to the community at large are not to be ignored in considering its effects as a whole. Hard as it is for the victims in such a catastrophe to admit it, it is very evident that few things so benefit a great city as the burning down of a large part of it. We are

* *Transactions of the Seventh International Congress of Hygiene and Demography.* Vol. VI. Architecture in Relation to Hygiene. Vol. VII. Engineering in Relation to Hygiene. London: Eyre & Spottiswoode. 1892.

much given, as a people, to boast of our progress and our progressive methods, the new things we introduce and the new way old things are applied, yet a wholesale conflagration, which will sweep away blocks of old work, or partly repaired and modernized old work, will accomplish more good for the benefit of the average city than months of discussion or volumes of writing. Civilization is a constant tendency to improve, but mankind needs, sometimes, a clear piece of ground to work on. The city of Milwaukee has no occasion, therefore, to look upon her calamity as an irreparable one. Much smaller than the great fires of Boston or of Chicago, it is not unlikely, as was the case with both these cities, to result in final benefit to the community, though unquestionably it now presses upon not a few individuals who can ill afford to suffer for the general good.

THE projected competition for the museum building for the Brooklyn Institute of Art and Sciences, the details of which will shortly be given to the public, has some points of interest which do not appear upon the surface. Contrary to the usual practice, the architects—for it will be limited to the architectural members of the Department of Architecture of the Institute—were consulted as to the advisability of a competition. The question to be determined was not their own individual wishes so much as the good of the Institute, which felt it could ill afford the expense of a competition if, by the simple selection of a single architect, a satisfactory result could be had. The question was a delicate one, for there can be but little doubt that among the younger members of the profession—who, in their own minds at least, have the ability and genius of older men, if not more—there was a strong feeling for competition. On the other hand the matter offered an unrivaled opportunity for the expression of a deliberate professional opinion on the utility of competitions in general, which would most unquestionably have helped to do away with this antiquated and Chinese method of securing the best things in architecture. The Chinese system and the young men carried the day, with what final results is still to be seen. A museum is a building calling for great special knowledge, and which has few types at all satisfactory in any part of the world. It is rather startling, therefore, to find half a hundred architects willing and eager to plunge into the work of a building requiring so much care and thought, so much special study and original investigation on what is, at the best, but a mere speculation. If the production of a museum building, or any other sort of structure, was a simple massing of walls, a throwing together of windows, doorways, cornices, columns, roofs, pinnacles, and stairways, the solution would be comparatively easy. But specialists in museum-designing, as is obvious from the simplest glance at the museums of this country and abroad, are not produced every day. The final results of the Brooklyn competition will be watched with interest, but the progress made thus far seems to be wholly in the wrong direction.

AN interesting paper on "The Construction and Interior Arrangement of Buildings Designed to be Used as Theaters' was read by Mr. C. John Hexamer before the Franklin Institute of Pennsylvania last spring. This paper was suggested by the burning of the Central Theater in Philadelphia in the early summer. Mr. Hexamer briefly reviews the fireproof construction needed for theaters, and argues strongly for the isolation of the theater-building, suggesting, as a corollary to this proposition, that they be erected in small parks or open spaces. This novel plan of beautifying our cities has much to commend it on the ground of safety, which, after all, is the only consideration to be taken into account in city architecture, but it is so contrary to current congestive methods of building as to be scarcely practicable. Obviously, however, some such idea must be adopted or stringent steps taken to render the entire vicinity of a theater fireproof.

CIVIL ENGINEERING.

Conducted by T. Graham Gribble.

THE Harman jack-knife bridge, as it has been nicknamed, but, as it should be more properly termed, the folding bridge, is well worthy of attention. It has hardly emerged from the crudities of invention, but it possesses features which may make it the best movable bridge for moderate spans. It is even possible that it may compete with the swing-bridge for large spans. The state of the art as regards movable bridges has been well illustrated lately by the competitive designs for a bridge over the Duluth ship-canal, to which we will presently draw attention ; but we will first summarize the several types of movable bridges hitherto constructed. They are :

First, swing-bridges. These are threefold : (1) Those having a center pier in the waterway about which the whole bridge rotates, so as to form two openings ; (2) those having their center of rotation on one of the river banks, the further end spanning the whole waterway and the shore end counterbalanced ; (3) those having centers of rotation at both banks, each shore end being counterbalanced and the outer ends meeting at the center of the stream.

Second, traversing or draw-bridges. In these bridges the river is spanned by the protrusion of the bridge either entirely from one side or by two portions, one from either bank so as to meet in the center.

Third, lifting bridges. In this type the entire bridge is suspended from towers at either side of the stream and counterbalanced like a window in its sash frame, so that the lifting required is only that due to the resistance of friction.

Fourth, bascules. These are bridges which might be also termed draw-bridges, because they are built on the same principles as those guarding the ancient castle moats which were termed draw-bridges. Either one or two leaves rotate about a horizontal axis like the lid of a box. All other rotating bridges turn about a vertical axis. The Harman folding bridge is a bascule having two leaves each of which has two independent axes of rotation.

Fifth, pontoon swing-bridges. In this type one shore end is on a pivot having a vertical axis. The other end is furnished with a pontoon which permits the end to rest on the bank, but, when the bridge is to be opened, water is pumped into the pontoon to lift the end off its bearing. The pontoon is furnished with a propeller and ferries the end round to the other bank, the bridge lying lengthwise of the stream and the pontoon running into a recess.

There is space here for only a few general remarks upon the relative efficiency of these various types.

The swing-bridge is adapted to the widest waterways and is most effective where there is plenty of room for the center pier. Its advantage is that it leaves the banks of the river entirely free to ships at their moorings, and that it requires no counterbalancing. Its disadvantage is that the center pier occupies that part of the river which is best adapted to navigation, and in a narrow stream leaves less room for vessels to moor two or three deep at the wharves. In the single form with a shore end counterbalanced the advantages previously stated are lost at the one end, while the waterway is, on the other hand, left more free.

The traversing bridge has the advantage of leaving a clear waterway, but it requires a considerable space for the overlapping ends, and it offers small resistance to a colliding vessel. It also requires considerable material for the counterbalance.

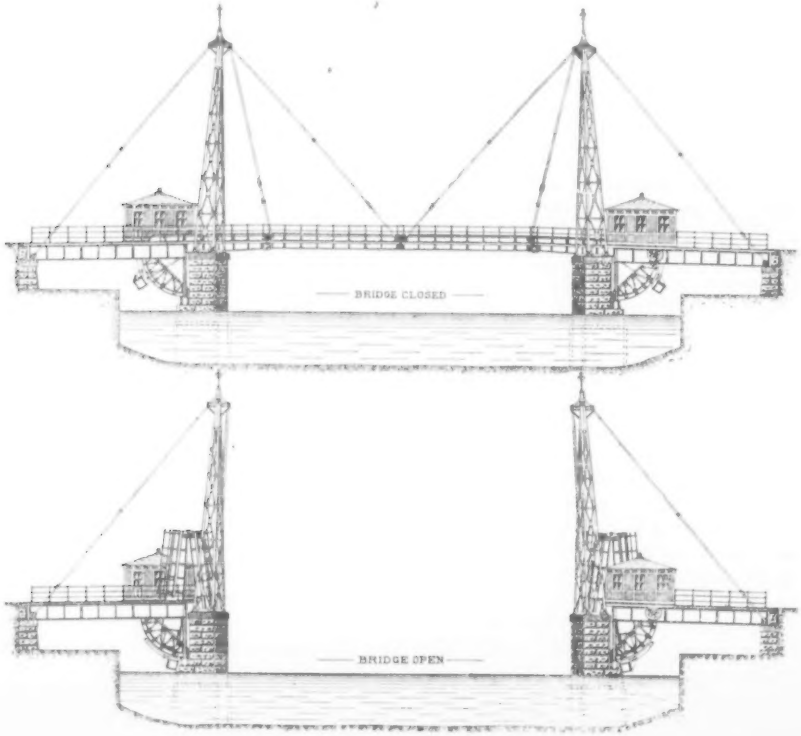
The lifting bridge occupies no more room on the shore than that occupied by the towers ; but these are expensive structures, first, because they have to be of great height to accommodate masted vessels, second,

because they must support double the weight of bridge, it being counterbalanced.

The pontoon bridge is a simple and cheap movable bridge. It gives a clear waterway with the exception of the space occupied by the bridge along the shore when open. Its disadvantage is that where there is a swift current the pontoon, unless provided with powerful engines, is slow in ferrying the free end round. It also requires a good deal of clearway for its sweep, and, generally speaking, is more suitable to waterways with moderate traffic.

The bascule, as hitherto constructed, is adapted only to small spans. The largest yet is at Copenhagen. It was opened in 1867 and covers a passage of 56 feet 8 inches. A pair of leaves counterbalanced at the shore ends flap upwards. The tail ends are unusually short,—13 feet 4 inches in length. The advantage of the bascule is that it leaves a clear waterway and is very rapidly operated. Its disadvantage is that the rising flaps are apt to catch the rigging of vessels, and, when in a vertical position, offer a large surface of resistance to the wind and upon a slender and vibratory base. The only bascule proposed for the Duluth ship-canal was a design by Messrs. John N. Ostrom and Thomas E. Brown, consisting of a pair of leaves abutting in the center and counterbalanced on the shore end. These leaves, when in a vertical position, would have been 125 feet high, and it is difficult to say whether they would have been manageable.

The conditions of the Duluth competition were: span 250 feet, single railway track, 2 electric railway tracks, 2 highways, and 2 sidewalks. The premium offered was $1000. Twelve designs were submitted. The premium was awarded to



Messrs. Arentz and Sangdahl for a single sliding draw-bridge, estimated to cost $236,000. It was decided afterwards that the cost was too great, and it was proposed to construct a lifting bridge designed by J. A. L. Waddell of Kansas City. The towers were 170 feet high, and the estimated cost was $125,000. Pontoon bridges were submitted by B. F. de la Rue and L. D. Grosvenor, of Jackson, Mich.,—one end pivoted, the other on pontoon with propeller,—estimate $108,000. Similar construction by Onward Bates and J. N. Warrington, of Chicago,—estimate $80,000. Single swing bridges were submitted by T. A. McNicol, of Providence, R. I., and double swings by E. B. Jennings, of Springfield, Mass. A double sliding drawbridge was submitted by Sooysmith & Co., of New York and Chicago.

The essential features of Harman's folding bridge are that it is a double-jointed bascule in which the outer joint permits the outer end of the bridge to fall down and so to cause the whole bridge to fold back against the pier. The portion of the bridge which rises forms an effectual barrier to the traffic while the bridge is open. It requires less counterbalancing than the ordinary bascule, is not liable to interfere with ships' rigging, and offers no resistance to wind, being folded up within the pier. It gives a clear waterway in the middle of the stream, and, last but not least, it is an economical bridge.

The first bridge built under Harman's patent has spanned the Chicago river at Weed street with an opening of 60 feet. In detail it is crude and clumsy, but it has worked successfully. The bridge in our cut is destined also for the Chicago river at Canal street. The span is 80 feet. The general appearance is prepossessing and the detail is carefully worked out. The cheapness of the bridge and the unobstructed waterway were the reasons for selecting this design instead of a swing-bridge. Messrs. Shailer and Schniglau are the contractors, and the detail has been worked out by the engineer of the company. Considerable ingenuity is shown in arrangement of motive power and counterbalancing. Instead of the unsightly rack-sectors usually seen in bascules, the bridge is operated by a solid-link chain and sprocket wheel under the floor. The counterbalance, instead of being hung at the end of the shore arm, is, as will be seen, attached lower down. This was necessary on account of the composite movement of the bridge. Unlike those of ordinary bascules, the leaves, when reaching a certain point, tend to close of their own accord. A position of counterbalance was obtained from kinetic diagrams, which would as nearly as possible correspond in its effect to the combined effect of the rising and falling flaps.

Both these bridges are designed for ordinary street traffic. The designers are prepared to adapt the bridge to railroad traffic and are confident of obtaining all the rigidity required. The fit of the ends is controlled by the outer forestay, but in addition a key will lock them together when closed. The tendency of the intermediate joint to knuckle up under a passing load is prevented by placing the center of the bridge and the two axes of rotation in one straight line. It cannot be expected that a double-jointed bridge will be as rigid as one with a single joint, but it is still quite probable that the bridge may be adapted to railroad traffic and prove the best form for waterways of considerable width.

THE experiments made by Mr. Moxham, of the Johnson Co., of Johnstown, Pa., upon a long stretch of street rail have created some surprise among engineers. The result in brief has been that a practically continuous rail 1160 feet long laid in macadam will not vary in length within a range of temperature of over 100° F. Mr. Moxham read a paper on this subject before the Street Railway Association this fall, and the experiments, conducted with great care, leave no room for doubt as to the general result. Mr. Moxham attributes the fact to the friction of the macadam against the sides of the rail, which however is open to some question. Another result of the experiment is that the temperature of the rail differed at no time more than 2° or 3° F. from that of the atmosphere,

and that only an equally slight difference existed between the top and bottom of the rail.

In the spring of the year the writer had a conference with Mr. Augustine Wright, of Chicago, with reference to the laying of a long stretch of electrically welded street rail, and suggested a thermometric test such as has been made by Mr. Moxham. He also worked out the alternating stresses which would be developed by resistance to the normal dilation of the material. The practical value of the experiments consists in the bearing they have on the joint question. No kind of splice yet devised has produced a joint equal in durability to the rest of the rail. Those which claim such a durability are very expensive. It is probable that electric welding will be applied to street rails combined with a polishing tool which will produce a perfectly smooth surface at the weld. It is true that the weld itself leaves the material slightly more brittle, but this may also be overcome. The difficulty of expansion has been the only one left to contend with, and the result of the Moxham experiments appears to remove it.

A maximum stress is produced in the rail under ordinary temperature variations in this climate of about five tons per square inch. Exceptionally severe seasons might produce as great a stress as seven and a half tons, but even that would not be beyond the safe working resistance of the material. Mr. Moxham considers that care would be needed in cutting a continuously welded rail on account of its possibly being under a great stress, but it is not clear that much precaution would be necessary. If we imagine a bar of iron such as a suspension link of a bridge drawn out in a testing machine and then suddenly cut in its middle, it would of course fly and knock all the gear to pieces, but if we imagine it, while under the stress, to be placed within an elongated vice extending all along its surface and squeezing it so hard that the pulls at either end could be removed and the material remain distended as before by the friction due to the pressure of the vice, we could then make one or more saw-cuts through the bar without causing anything to fly. The rail is in precisely the same position with regard to what holds it. The effect of cutting a continuously welded rail for purposes of repairs would be as follows: if it were very cold weather and a long stretch of rail were exposed, the material being in tension, the rail would part before it was sawn through with a loud report. If it were very hot weather and a long stretch were exposed, it would begin to buckle and might fly sideways. If however only a short length were exposed, it would be sawn through without any attendant phenomenon.

Mr. Moxham attributes the vice-like pressure to the friction of the macadam. This friction has a good deal to do with it, but it can hardly be debited with the whole amount. The total stress to be accounted for, produced by temperature in a rail 1160 feet long, is about 120,000 lbs. The coefficient of friction of iron on soft limestone is 0.49. If the rail were inserted in a limestone templet, fitting it accurately all round, it would only require about 40,000 lbs. to drag it through the template. It cannot be that any amount of tamping of the macadam can produce such a complete contact as the one just described. It is more natural to suppose that it is the fit of the chairs which mainly forms the vice. The Johnson chair grips both flange and shank and is drift-bolted down to the cross-tie. This is a very much firmer attachment than the spike of steam railroads. The tamping of the ballast would drive the grit between the two metallic surfaces and form a thoroughly vice-like grip, the tamping would also pack the cross-ties so as to preclude their movement, and the chair is prevented from sliding on the cross-tie. This theory could easily be tested by experiment as follows: Let a piece of rail twenty-four feet long be laid down, without any cross-ties, upon a bed of ballast, then boxed in with ballast on either side. Place a dynamometer at one end and start it, noting the power required.

Next place the same rail on six or seven cross-ties, the space between the ties being well packed with ballast or else the ties themselves planked with distance pieces so as to prevent them from moving. Let the

chair-joints be well filled with dust or grit and spiked down, with the space round the rail-surface otherwise clear; then let the dynamometer be recorded in the same manner. Even if no chairs were used in the experiment, it is probable that the ordinary spike attachment would hold more than the ballast friction. As regards the economy of continuous rails, the saving would be in the first cost of fish-plates and in wear and tear of joints. As a set-off against this saving there would probably be an increased wear of the rail all over. Alternating stresses necessarily involve wear, or, as it is technically termed, "fatigue" of material. When resting on isolated supports, such as chairs, the rail head is under direct compressive stress during the passage of the motor-wheel. In hot weather this stress would be augmented by the stress due to temperature, and wear would be facilitated. In iron rails the wear is exhibited by exfoliation, owing to the laminated character of the material. In steel rails the action is similar though less marked, and the tendency to abrasion would certainly be increased by a high compressive temperature stress. Apart from this combined action of the two stresses, the mere fatigue of material would not bear any large proportion in the life of the rail, which in street traffic is due mainly to abrasion, often more from the ordinary verticular traffic than from that of the cars. Moreover, if the rails were laid at maximum temperature, there would be no compressive stress from that cause afterwards. Probably the amount of extra wear would be less than that at the best of joints, and it is to be hoped that we shall soon see a good stretch of electrically welded rail laid down.

Under present forms of construction it is questionable whether the continuous rail is applicable to steam railways, but the day may soon come when the present intermittent transverse supports will give place to a continuous longitudinal support with a continuous fastening, and then the electrically welded rail can be made to apply to trunk lines also. Even under present conditions the use of a chair instead of the ordinary spike might be a sufficient attachment to admit of a continuous rail.

A paper was read last month by Mr. B. H. Colby on "The Recent Survey of St. Louis, its Methods and Results," before the Engineers' Club of that city. The area of triangulation exceeded 27,000 acres, and the work cost $1.15 per acre or 14.5 cents per lot. The paper was of considerable value in showing the degree of accuracy obtainable by precise methods, both in triangulation and leveling. The error of closure in the triangles averaged 3.7 seconds and the mean error per angle was 1.2 seconds. The heliostat was used in preference to poles, and gave better results. The method of taking multiple readings of the angles was explained on the principle of repetition. The transits read to 10 seconds. In leveling the average error was $\frac{1}{1000}$ foot per mile, and the maximum error permitted was $\frac{5}{1000}$ foot per mile. If the error of closure was larger, the work was done over again. A stadia survey was also carried around the perimeter of St. Louis, covering a distance of 40.4 miles. The maximum error in azimuth was 12 feet 3½ inches at a distance of 34.9 miles, and the closing error was 8 feet 2 inches. The error in altitude in closing, after running the 40.4 miles without checking on any intermediate benches, was $\frac{44}{100}$ foot with a maximum of 1.37 feet at the twenty-seventh mile. These last results, considering the nature of tacheometric instruments, are perhaps the most remarkable of any, especially if the distances between the instrumental stations were themselves determined by the stadia.

THE reissue of Mr. Flynn's standard work on irrigation canals and hydraulic engineering will be found acceptable to the profession. It is more portable in two volumes than in its former shape. The tables on flow of water in open and closed channels are very complete and well arranged. We have already accorded the book so hearty a commendation that no more need be said than to indorse the previous review of the book in these pages.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

AGITATION for a change in the United States law regulating the extent and title of mining claims recurs once in a while. It should be sustained, until the law is properly amended. The strange thing is that, while everybody—except perhaps the mining lawyers and a few court experts—admits that the present law is unsatisfactory, nobody seems sufficiently interested to make a decided move for amended legislation. Here is an opportunity for some of our Western Congressmen who are familiar with the subject to do a great public service. The millions of money and the time wasted in litigation, and the uncertainty of titles even after the "patenting" of claims, are most deplorable and are surely reason enough for an exertion toward improvement.

Space does not permit a description in detail of the intricacies of the present law in its application to actual cases. Mining men fully realize them. For those who have not considered the matter, it may be said in brief that the case is so bad that there is hardly a good mine (of the class involved) which has not been through the courts, and that every one worth contending for may be expected to have to fight its way likewise. The situation is, if anything, worse than that of inventors' patents, whereas it need not have been more complicated than in the settlement of boundaries and titles to ordinary real estate. A rough sketch may make this clearer to those not already informed.

The act passed by Congress in 1872, and still in force, covered the location of mineral lands in the public domain, and consequently holds throughout the Territories and the States admitted since, and is also in force in the older Pacific-coast States. It supplanted a variety of discordant local regulations made by the miners themselves for the different districts, and, without interfering with previously existing rights, established a uniformity of rule for subsequent locations. It was extremely liberal as to the amount of ground allotted in each "location," and thus favored prospecting. So far it was an improvement. As to the provisions regulating placer claims, mill-sites, and tunnel rights nothing need be said. The trouble is in regard to deposits of ores "in place," as distinguished from the secondary placers and minerals "located" under the same head. At the time the law was enacted very limited conceptions prevailed as to the mode of formation and occurrence of such deposits. Our legislators had in mind a particular type of vein mines only, of more or less regularity and simplicity, and they framed their law in accordance with supposititious conditions. It happened that the gold and silver mines then working were nearly all of the kind taken as typical, and the law fitted them after a fashion. Unfortunately nature had not planted all or most mineral deposits to suit this ideal notion, and the law has never since been brought into harmony with all the actual conditions (if indeed that were possible); though later discoveries, especially those of the important but extremely irregular silver-lead deposits in limestone, have opened up a host of puzzling exceptions. The law fixes the length of claim at 1500 feet along the course of the vein, making the end lines parallel with each other and continued downward in vertical planes. The side lines, however, 600 feet apart, apply only to the surface, so that the owner is entitled to follow his vein (or whatever it may be) down on the dip underneath and beyond his side line on under an adjoining claim. This, omitting accessory complications, is the central idea, and it will be at once seen that it may (as is frequently the case) give rise to dispute in irregular deposits when

it is hard to prove continuity. Then there is the question as to who owns the "apex," which is the main vein, etc. In a mining district it often happens that there are, instead of a few well defined, non-intersecting, and widely separated veins, a multiplicity of them, sometimes closely adjoining, and perhaps intersecting at various angles, where the geological relations are very hard to decipher. But the law ought not to rest upon the uncertainty of geological theory, applied usually without sufficiently extended underground workings to give the experts a fair opportunity for observation. It ought to be so simple that an instrumental survey could always determine boundaries.

The filing of an original location claim by the discoverers having been found insufficient for security, it was thought that giving him or late owners a patent, based upon a surface survey and after publication of notice to adverse claimants, would secure possession. But experience has shown that, while the expensive and tediously-acquired patent is some protection, it is by no means final.

Miners are almost unanimous in favoring what are called "square" locations. That is, let the discoverer take up a certain legal surface area not necessarily *square*, though that shape is preferred. Then give him title to everything within his boundaries, making all the limits alike vertical, so that he cannot go beyond them underground, and his neighbor cannot come within his. This is just what is done with the iron, coal, copper, lead, and other mines of the eastern half of the United States and in many foreign countries. It simplifies matters and works no hardship whatever to the discoverer, if the limits are wide enough to allow plenty of scope on the dip. Widening the claims would tend to a corresponding shortening, to avoid giving too much ground to one locator, but the protection would be more than an offset. An area of 1000 by 1000 feet would be liberal, giving 100,000 square feet more than the present full claim, with the added right to any undiscovered mineral within the lines. Perhaps a slightly smaller area would be more judicious, so as not to exclude other prospectors too much. As to this, opinions are not agreed; but it is a matter of detail. The main thing will be to avoid so far as possible uncertainty as to title to mineral locations to be found in the future, and this can be accomplished without impairing existing titles. It ought to be done, and the sooner the better. New districts are being constantly opened, and these are going through the same old course of legal entanglements, to avoid which the owners of conflicting claims find that the best thing they can do, under the existing system, is to buy out each other, compromise, or consolidate, and religiously shun the courts.

MINERS and smelters do not agree among themselves as to the national revenue policy, either in the details of its application or even in general principle, any more than do the politicians or the public at large. What they heartily do concur in is a feeling that this country ought to have a fixed economic policy of *some* sort, no matter whether it exactly suits them or not; also that, if this is not to be had, at least suddenness of change should be avoided, whether in the direction of increased, diminished, or annulled duties on imported ores and metals. After establishing a costly plant, based upon a promised supply of foreign ore and metal free of duty, it is pretty rough to find that source abruptly shut off or made more expensive. On the other hand it is equally disappointing to those who may have put up large works on the expectation that foreign supplies would be excluded for a long period to have that protection suddenly lowered or done away with. Whether a man interested in ores or metals is a protectionist, a low-tariff advocate, or a free-trader, he would like to be able to see a few years ahead with assurance, and not, in addition to the natural risks of mining and metallurgical enterprises, have to bet on what the politics of the country are to be from time to time. It is not only the actual change which may occur, but the apprehension of one, that makes trouble.

The recent decline in the price of lead concurrently with the announcement of

the result of the November election, for example, may or may not be attributed to a belief that the incoming party would forthwith remove the duty on imported lead ores. An ore is, of all things, certainly a raw material of the rawest kind, and in accordance with the free trade principle should be one of the last things to be taxed. No one, however, seriously imagines that it is proposed to turn the existing economic system of the country upside down in a jiffy. On the contrary we have the assurance of the leaders of the Democratic party that adjustments to a new order of things, which seems to be demanded by the people, will be made gradually and conservatively. The occasion was marked by a small alteration in other metal quotations; but the fact that they were no larger argues a confidence in the prudence of the next administration All the same, it would be a great thing for investors in mining and metallurgical enterprises, which often call for the sinking of large capital and sometimes mean a long delay before production and profit can be looked for, if there were a common consent, an unwritten law, in this land either that the economic changes directly determined by legislation should be made by successive small steps, or, if to be brought about in the lump, that a notice of the impending change should be given well in advance of the event, as was done in the resumption of specie payments in 1879, so as to permit a gradual readjustment of things.

Now that the excitement of the political campaign has subsided, there is no pressing occasion for one kind of misrepresentation about silver mining. Some newspapers published in the silver-producing regions have, for partisan purposes, been industriously misrepresenting the condition of the silver-mining industry, claiming that there is now no profit in it, that the mines are closing on all sides with a general cessation of work sure to follow, exaggerating the decline in production, and trying to create the impression that everything would go to the dogs if their particular political and monetary program were not carried out. This is just as bad and just as stupid as the too frequent misstatements in the other direction as to the fabulous possibilities of the mines. As usual, the truth is midway between the extremes. There *has* been a temporary back-set in silver-mining, a decided falling off in profits, and a smaller output than might have been made under more advantageous conditions. The recent low prices for silver have undeniably had a depressing though not a disastrous effect, and the market unquestionably declined on account of the failure of attempts to legislate in favor of silver during the last session of Congress. But this has not made the situation a desperate one. Nor, on the other hand, are there any mines capable of indefinitely increasing their product. One form of misstatement repels investment; the other deceives and for a time attracts it, with the inevitable reaction. Both alike hurt the industry.

While engineering questions of all sorts can be discussed without acrimony and without personal feeling, unless business interests, as in the case of patented machines and methods, are involved, no sooner do mining engineers begin the discussion of geological theory than the argument becomes heated and the air is full of bricks. They start in with the laudable desire of reaching the truth, to arrive at which it becomes necessary to consider opinions as well as facts, for it is only by poking about tentatively in different directions that one gets his bearings for inductive reasoning. Fortunately, in a multitude of opinions there is a variety to choose from, and out of the tumult and the clashing of ideas something substantial is sometimes evolved. But it does seem odd that, when the engineers tackle a geological conundrum, as they often have to, they wrangle very much like the geologists themselves, to whom a certain latitude in respect to parliamentary usage is conceded. Engineering proper is an approximation to an exact art, so that its problems can be referred to precise tests with the prospect of final definite solution; while economic geology is still obscured by much indefiniteness and thus admits of wide differences

of opinion not susceptible to simple proofs because the wide range of observed facts have not yet been systematized. However, economic geology—that branch of geological science which bears directly upon mining—is making steady progress, and in part rests upon very solid foundations. Already it has cleared up many of the uncertainties of coal mining and the search for petroleum, natural gas, salt, and other substances; while the advance made in understanding the origin and conditions of metalliferous deposits is by no means insignificant. In this latter field it has a great future, of which we now have but faint realization.

IF the projectors of metallurgical establishments could only foresee the future of their works, it would give them an immense advantage. Plans have to be modified by trying to strike a mean between at least two distinct conditions, first, the immediate needs, and, second, the probable extension of capacity. Sensible men always design works of this kind with an eye to possible additions, but as it is not easy to guess how large or how soon these may have to be provided, they do not like to depart far from what would be considered a proper arrangement in case the original conditions were to be maintained. The dilemma makes trouble both ways. It is not exactly pleasant to design a plant having a large surplus of engine-power or covered area for example, to allow for possible additions of machinery, furnaces, etc., since the effect at the outset is not only unsymmetrical, but involves an extra first cost to be charged at once into the working balance sheet. On the other hand, it usually happens that, when the time for enlargement does come, the forethought turns out to have been insufficient or misdirected; so that in adding to the plant there is likely to be an awkwardness of arrangement that is prejudicial to rapid and economical handling of material.

The case is analogous to that of municipal engineering. If a city of say a million inhabitants were to be planned and provided for *de novo*, and if it were sure to grow and never change its requirements, there would be a beautiful opportunity to lay out all the systems of streets, parks, water supply, sewerage, rapid transit, lighting, subways, mains and connections, etc., once for all, supposing that no decided innovation were brought about by the progress of invention. There would be a consistent adjustment of everything. In actual practice the reverse happens,—temporary makeshifts, compromises, remodelings, and either too ambitious or too timid provision for the future. So with metallurgical establishments. No matter how big and complete they are at first, if they are successful at all they are very likely to grow. Of course we are not considering those which are out of all proportion to begin with; and indeed mistakes of this sort are not very frequent latterly. In the older works, which have passed gradually from small beginnings through various stages of enlargement up to their present capacity, the relations between the old and new plant and buildings are generally unsatisfactory, resulting in clumsy handling and transfer of ores and products, duplication of work, etc. Even such apparently simple matters as choice of site and utilization of natural grade seem to have been often carelessly treated. Such things are a warning to the designers of the present. It requires a nice adaptation of means and weighing of conflicting elements to make plans that will not look foolish a few years later. Whoever can do this must be farsighted, without being visionary.

A VERY thorough analysis of the relative merits of the many different types of safety-lamps is given by the *Colliery Engineer*, which rates the most important requirements in the following order: (1) safety in strong ventilating currents; (2) greatest susceptibility to the presence of gas, and (3) good illuminating power. On this basis a comparison is made between the several models, and those which best meet the requirements are discussed. It is impossible to give here an adequate digest of the paper, which should be read in full by those interested, but it is worthy of remark that the tests quoted prove that the problem of producing a lamp for deli-

cate, quantitative gas-testing purposes has been solved. As to the illuminating power of safety-lamps there is evidently much to be desired, though recent forms show an improvement. Assuming a candle to have an illuminating power of one, or unity, the *Colliery Engineer* gives the results of tests showing that the Davy has an illuminating power of but 0.16; the Geordy, of but 0.10; the Clanny, of 0.20; the Muessler, of 0.35; the Evan Thomas, of 0.45; the Marsant, with three gauzes, of 0.45; the Marsant, with two gauzes, of 0.55; and the Howat's Deflector, of 0.65.

IN coal-mining the use of the incandescent electric lamp is making some progress, but not rapidly. There are two rival systems proposed, that of the lamps fed by wire from outside dynamos, and that of the independent portable lamps having their own storage batteries. The latter of course are rather heavy and awkward. As to the former, claims are made not only because of their vastly higher lighting power as compared with gauze safety lamps, but also on the score of increased safety. Opinions differ about this. The *Black Diamond* says the discussion has given rise to the suggestion that some definite test should be made to determine the exact status of the incandescent lamp in case of breakage in a mine where dangerous gases are present. Of course it is not proposed that the risk of an explosion should be invited before the subject has been satisfactorily solved, beyond dispute, but it should be a comparatively easy matter to attain this solution in the laboratory, where every facility is at hand for the performance of such an experiment. It would be highly interesting, for if it can be shown beyond doubt that the incandescent lamp possesses attributes of a lighting agency far beyond any of the known existing lamps, its general advent in the mines throughout the length and breadth of the land will only be a matter of a short time.

THE Poestch refrigerating process for shaft-sinking in quicksand has been more extensively applied in French coal mines this year. Another method of dealing with quicksand has been invented by Mr. R. L. Harris, of New York, and is equally ingenious, buts acts on a new principle. Taking advantage of the permeability of quicksand to water and other liquids, water is forced in under pressure through pipes in such a way as to form a chamber filled with water instead of quicksand. Cement is then forced into the water-chamber so formed and also into the surrounding earth. If the quicksand consists of material which can be utilized as a constituent of the cement, that quality is utilized.

IT may not be generally known that the "miner's inch" of water, formerly so variously defined and measured in different mining districts, has been standardized in the State of California as the quantity of water which will flow through an opening of one square inch in the bottom or side of a vessel under the pressure of four inches above the opening. This is not absolutely precise, as it makes considerable difference whether the edges of the discharge opening are thick or chamfered, and in the measurement of large volumes an aperture only one inch high across the stream is too small for convenient gaging. But the main point in the present legal definition is that, whereas some years ago the pressure was commonly gaged at six inches above the orifice, the standard pressure now is four inches.

FREQUENTLY the technical press announces the introduction of a new alloy for which great claims are made. Later, when time sufficient for experimentation and tests on the working scale has elapsed, nothing further is published, except in the comparatively rare cases where a decided success is attained. For instance, some time ago a new steel, containing 2 to 4 per cent. of copper, was heralded. It was claimed that the addition of the copper imparts greater resisting strength, elasticity, and malleability to the metal; from which statement and from the fact that the news came from the great Schneider works at Creusot, France, it may be presumed that it was intended for armor plates. But what has become of it?

MACHINE-SHOP NOTES.

Conducted by Albert D. Pentz.

THE getting of commercial results in the manufacture of machinery is after all the criterion of success in the present stage of progress, and it is easier, comparatively, to devise a mechanical success than it is to market one and make it pay dividends. The keynote to successful manufacture is the making of the articles cheaply and well, for if they are not made cheaply they cannot be made to pay, and if they are not made well they cannot be sold steadily or have a lasting demand. Hence a man who is capable of economically duplicating a good device has more value to the producer, as well as to the consumer, than the inventor has. The grand secret of manufacture is, first, to do it,—not to begin, not to get ready, but to do it. Get the material in, and get the work out. Do not permit a single cost or excuse to stand in the way of this result. The second secret is to make each succeeding lot of the output cheaper and better than the last. In this connection, because every concern must do its business on the principle that each article is to be sold at a stated price, it follows that each must cost a fixed price, and this idea prescribes that piece-work shall be the sole method of paying for the manufacture. And there are no paying industries in this country that do not employ piece-workers as a rule. There may be obscure or belated factories doing day's-work manufacture, but they either do not pay their owners as they should, or the output costs the buyers more than it should. The third point is to push the work by constant unremitting energy and vigilance. Go to the assembling-room and insist on larger production. Listen to the complaints there made of lack of material from the other departments and of suitable help. Then go to the other rooms and demand that they get out more work, and then listen to the complaints made of inferior castings or other stock and of insufficient tools and room. Listen to all these complaints and investigate them for facts. Supply the deficiencies and push harder every day. Herein is the secret of economical manufacture.

IF a person, when he wants a machine-tool, could wait six months for it, until he could examine all that are made of the kind he desires, he would then be able to select the best, if his judgment could be trusted to tell what is best after so prolonged a siege. Now most tools are selected quickly, because they are needed at once, and what appears to be the best is taken and set to work. Hence many poor tools are got where better ones should and would be taken if more time for investigation were had. There are of course establishments where the most suitable tools are selected and recommended by experts, and a few of these deserve all praise for candor and fairness, but many of them do not push forward the best tools, but advocate instead those most profitable to them as dealers, and if a buyer falls into the hands of such he may suffer for it. There seems to be a need of a more perfect means by which buyers can be made to know the comparative capacities and values of machine tools, so that when they need such tools they may not be in any great doubt as to that which is nearest to their wants.

THERE is one thing that Blunt has learned well and by many experiences,—namely, that the man who buys for himself saves considerable money. So he usually did all that himself. In his absence lately it was not distinctly understood who should do this; so Charley Gaul permitted the commercial travelers to entertain him with descriptions of their marvelous wares. One day a particularly fine talker got him interested in a new oil that was a lubricant of great value if one tenth of the claims were

true. He ordered a barrel of it and refused an invitation to dinner. This invitation did not look right, so he called halt.

"Say, I'll call the manager. He ought to know all about oils; he's a college man."

"All right. I can stand the college fellows, but I despise the shop men."

"Mr. De Gree, this gentleman has a new oil for lubricating fine shop tools. It is used and recommended by the Universal Electric Co., the Mogul Engineering Co., and—Snow him those letters, Mr. Lingey."

The letters were all that the most exacting person could desire, and more. De Gree had never heard of so good an oil as they described.

"We have enough oil to last until Mr. Blunt returns," said De Gree, "but you may send us one gallon for trial, that we may be able to report upon it when he comes."

"This oil, sir," said Lingey with some impressiveness, "has passed the experimental stage, and we do not send out less than one barrel. If these letters do not satisfy any one as to what that oil can do, nothing in the world will."

"If we needed oil it would be different, but as it is, we will take your testimonials and report to Mr. Blunt on that."

"That oil is selling to-day for 47 cents. In one month it will likely be 60 cents."

"We will not buy to-day."

"Good morning."

When Blunt returned, De Gree showed the testimonials and told his chief about the oil man.

"These letters are n't worth the paper they 're printed on. Every one of them is written by a man who does not know oil from antimony. I don't know what the machine business is coming to. Generally when a big company is formed, a favorite or a relative of some member is made buyer, and the drummer who can talk the smoothest sells his goods. I tell you, sir, if there is one place more than another in a large concern that requires an honest, shrewd, experienced, practical man to make money in, it is the buyer's. There is Charley Gaul, now; he could sell a bill of goods to Daniel Dancer at list-price, but he is just soft enough to bite at the clumsiest kind of a bait himself. I'm glad you got away from that fellow."

INDEPENDENT of the great technical value to engineers of a knowledge of geometry, this study has another, and I believe the greater, value,—of discipline in the necessity to prove and demonstrate a problem so far that there is no place for doubt in the answer. The method of the geometer in design is the only safe one, and that is to know absolutely just what each member of a machine can do, from the most searching analysis of it possible to make before that element is accepted. The practical man of wide experience will know the behavior of many kinds of movement which he has used before, to a certain knowledge, and he will not need to demonstrate such to accept them or to know their limitation. But such as he does not thoroughly know by practise he should demonstrate before using. The effects of every movement may be found on a sheet of paper graphically with the dividers, and with the law that motion and power are inversely equivalent to each other constantly in view, the precise results of every movement may be found very simply. The writer generally demonstrates a movement, however, by constructing it from pasteboard, using common pins for fulcrums and journals. This method does not take so long and no errors of numbers can creep in. Besides, there is satisfaction and safety in seeing a thing move that can come from no other kind of demonstration.

THE directions in which malleable metals flow under pressure or blows may well be made the subject of extended observation by every engineer. If struck on top by a flat hammer or ram, the tendency is not so much to be driven deeply into a design on a lower die as it is to flow sidewise, unless the design is so proportioned and its recesses so distributed over the lower side as to demand and receive about as much metal in one place as in another, in which case there will be no pronounced side flow.

Thus a design composed of radial or involute corrugations will be filled perfectly, while a deep annular pattern may fill and then be sheared off. I have known a design to nearly fill on the first blow, and on the second blow to be scarcely distinguishable in consequence of the metal flowing away and removing the first impression from its position within the die. In roughing out or forging stock to be dropped in a press, it should be made to bottom on the dies first and before the sides are filled if practicable; for otherwise the internal outline corners will be filled only with great difficulty. If the roughed-out stock bears on the cheeks of the dies, and if it does not touch the lower parts or nearly touch them, the blow will at once form a very refractory fin and expend its force in compressing that fin between the faces of the dies. Where two or more blows are to be struck, the first die should make a blank the vertical cross section of which will be proportionately high and narrow in every detail; then the last compression will fill the die perfectly by utilizing the flow instead of opposing it. This is the most effective treatment for either metals or men; the best effects come of directing their peculiarities toward desired results rather than of forcing them to fit our peculiarities.

A FRIEND told me that he had found brass at a certain temperature capable of being swaged and bent much more advantageously than when cold. By a question I ascertained that what he called brass was a composition largely of zinc, with perhaps a trace of lead. By another question I found that he was not aware that cast zinc is malleable within a limited range of temperatures; that it is brittle above as well as below that range; and that his temperature for bending his brass was well within that range. Now this friend had experimented exhaustively on these temperatures, and found that which gave him the best results in bending, but if he had thought to read what has been written of the traits of the constituents of his alloy, he would very likely have had no experimenting to do. Thus we do not think about what has been done, but go ahead and rediscover—or fail to discover—truths that are of easy access to every one. Often we do not recognize an old problem in a new guise. Oftener we do not think about it at all, but dive into it unmindful of the fact that much of the data of what is knowable of material things have been discovered and are contained in a small number of books.

WHATEVER form or character the collars that locate a shaft or a spindle may take, they should embrace only one and the same journal-box. If they do not, then when that shaft or spindle elongates by the heat of friction, these collars, if they are fitted between two journal-boxes, will bind and cut, or, if they embrace two boxes distant from each other, they will open when extended by heat. When they are on each end of the same journal-box, however, the shaft or spindle and that box will each expand and contract about equally and will neither bind nor shake.

THE ability to design a drill jig that will work perfectly and quickly, or a milling fixture that can be depended on to support effectively the piece being operated on, is of more money value to a man or to any machine-shop to-day than a knowledge of the integral calculus, and men who are being prepared for mechanical engineers ought to know it. The indications are strong that this will continue to be a fact and be more pronounced as long as machine-shops are run for the profit there is in them.

ORDINARILY it is best to remove all the material to be cut from surfaces on cast-iron pieces as a first operation. The reason for this is that, when the metal is taken from such surfaces, the internal strains are partly relieved, and the piece will change in shape. When, therefore, holes having positive relations to each other and to other working points have not been made after the removal of masses or extended areas of metal, these holes will be found to have changed in their relations to each other after such removal in almost all such cases.

COMMENT & CRITICISM.

The Mississippi Problem.

A MAN should never enter a controversy which involves a knowledge of statistics without putting himself into complete armor.

"Many extravagant statements have been made," says Mr. William Starling "about the amounts already expended for levees. Up to the present it is probable that $35,000,000 will cover it."

Now, the amount of the appropriations made by the United States alone for the improvement of the lower Mississippi foots up more than the full total conjectured by Mr. Starling. The figures are taken from Congressional records, and, to be exact, they amount to $35,422,125.73. From this total must be subtracted about $8,000,000 expended on the Eads jetties. But there still remains a total of more than $27,000,000. Add to this the total of $22,000,000 expended by the States since the close of the Civil War, conceded by Mr. Starling, and we have a total of nearly $50,000,000. The only uncertainty, then, is as to the amount expended by the States and by individuals and corporations working desperately in emergencies. These considered, it would be very strange if the full total is not even greater than the estimates which Mr. Starling pronounces extravagant, amounting to about $100,000,000.

Mr. Starling speaks of the expenditures for dike building as something to come to an end when the dikes are completed. But he should know better. The current of a tortuous stream like the Mississippi, impinging forever on its banks and finding oppprtunity for the exercise of its most destructive force in the concavities of each bend, would eat its way through any dike that could be constructed, if not strengthened by jetties, every few years. Mr. Starling knows this. He cannot have forgotten the wrecked depot near New Orleans in the recent flood, even had he not many other examples of the irresistible power of the current for his instruction. I still maintain, as I maintained in a former contribution to these columns, that in dike building on the Mississippi we have entered upon a work that will call for the expenditures of hundreds and finally of thousands of millions of dollars and still carry us further and further from the true solution of the problem.

Another point too in Mr. Starling's article must not be overlooked. He expresses something very like surprise that any one should have accepted the idea that building dikes helps to raise the bed of a stream. He calls it an ancient idea and says that it is opposed to all testimony. Now, as a matter of fact, it is not opposed to all testimony, and it is entirely consistent with the physical laws that operate in the formation of rivers. The mouth of the Mississippi was once at the present site of Cairo. Then how did it reach its present level, 300 feet *higher* than its old level at the mouth of the Ohio? Mr. Dutton, who is perched upon a dike alongside of Mr. Starling, calls the rise a result of volcanic action. But volcanic action never produces a vast and almost perfectly level expanse of sandy country. Such formations are produced only by the persistent pushing out of the mouths of rivers into the ocean, and the rise in the beds is due simply to the natural deposit of sediment washed down from the mountains and highlands to help form the surface of a constantly rising inclined plane. Then how is it possible to cart dirt to the edge of a stream, where it caves off and finally forms a part of the bed, without contributing largely, though abnormally, to the processes of nature.

When all the *disinterested* testimony in our possession points to the conclusion hat dikes do raise the bed of a stream, the case becomes overwhelmingly strong. The

mouth of the Mississippi is still pushing southward. The bed is still rising to meet the new requirements of the prolonged and prolonging inclined plane. Shall we continue contributing our dirt until we have finally raised the bed above the adjacent country? Or shall we help nature in its conquest of the Gulf of Mexico by giving to the river a shorter and more swiftly flowing passage to the outlet, and give the winds a chance to level up the adjacent country to its proper grade?

As I had occasion to say in my first article on this subject, the original dike raised to prevent the overflow of a river was the conception of a savage; and down to date civilization has contributed nothing to its evolution. Men have only acquired the ability to expend more money in the construction of dikes, and by building them higher and higher to load the current with a larger quantity of sediment than it can ever be expected to carry to the sea. In exceptional cases dike building may be necessary as an expedient; but it is hardly defensible as a principle of engineering construction under any circumstances.

Mr. Starling seems to think that the stream would not follow a direct line if it were offered one; that the caving of the banks would throw fresh obstacles in its way, causing it to push out its forces laterally for the creation of new bends, and he calls attention to the disappearance of six miles of the bend at Vicksburg a few years ago and the subsequent recovery of four miles of it. But this really proves nothing except that nature needs a little intelligent coöperation from human hands.

We shall have nothing to fear from new bends when the channel at the Mississippi has been made uniformly straight, and given as nearly as possible a uniform flow of water. The most that could be anticipated would be that at certain points, on account of local conditions in the soil, weaknesses in the banks might be exposed. But such points, if any were found, could easily be reinforced by jetties and made entirely secure. Give us 600 miles of a direct waterway with a uniform current of about four miles an hour, and we could easily manage it. It is our 1200 miles of tortuous waterway with sometimes a current of two miles an hour, and sometimes next to no current at all, but subject to an occasional tremendous flooding, that gives us all our trouble.

It is to be feared that our Mississippi engineers are too fond of building technical theories without any very close observation of natural phenomena. The very fact that one of the champions of the levee system, whom I have been compelled to meet with his visor down, thought the Mississippi basin the product of a "cataclysm," which I suppose means an earthquake or a volcanic upheaval, shows the superficial character of the studies through which their science has been informed. It is a pity that these engineers will not go out and observe the operations of practical men who have low-lying lands to keep free from water. The whole Mississippi problem is simply a question of drainage.

A SOUTHERN ENGINEER.

The Engineering Magazine in Shanghai.

I HAVE found the people in the city of Shanghai, as well as aboard our ship, very much interested in reading your Magazine. I now have a list of those who want to subscribe for it next year, and I would like to get some of your subscription blanks so that I may do my best to get it into circulation among the many mechanics out here in China. I have not been in Japan yet, so do not know what I can do there. I have been a subscriber ever since the Magazine came out, and I never saw a better publication. I am sure it is *the best mechanical paper printed in the United States of America.*

I will have been in the United States Navy one year on the 15th of next month, as blacksmith on the U. S. S. *Petrel*, and we are now on a cruise up the Yang Tse Kiang river. We have been in this river four months, and I do not know how much longer we shall remain in this region.

Yours very truly,

PHILIP JOHNSON.

Han-kow, China, August 28, 1892.

CURRENT TECHNICAL LITERATURE.

TO THE READER.—This catalogue is compiled from the technical periodicals of the United States, England and France. If you were to subscribe only for those of most importance, it would cost you over $500.00 a year. If you were to undertake to read them, you would do nothing else from year's end to year's end. To subscribe for THE ENGINEERING MAGAZINE and get the benefit of this catalogue costs you but $3 a year. To glance over those departments of the catalogue in which you are chiefly interested, and decide which of the articles listed are of real value to you, requires but fifteen minutes of your time each month. If you have taken the precaution to purchase a stock of our coupons, it will take you but ten minutes more to fill out, say a dozen, and enclose them in an envelope to THE ENGINEERING MAGAZINE COMPANY, WORLD BUILDING, NEW YORK. No letter-writing is required. A stamped envelope does the work. In return you will receive the dozen articles desired, though they may be published at a dozen different points in the world.

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In the body of the index the initials of the papers quoted are given, and these can be readily identified by the alphabetical list of periodicals below. Other abbreviations are: Ill=Illustrated; w=words.

THE AMERICAN PRESS.

A S .....Age of Steel. *w.* $3. St. Louis.
A An.... American Analyst. *f.* $1 per year. N. Y.
AA.....American Architect. *w.* $6. Boston.
A Ar.....American Artisan. *w.* $2. Chicago.
A C J....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D.....American Druggist. *m.* $1.50. New York.
A G L J...Am. Gas Light Journal. *w.* $3. New York.
A G .....Am. Geologist. *m.* $3 50. Minneapolis.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..American Journal of Railway Appliances. *m.* $2 per year. New York.
A M ....American Machinist. *w.* $3. New York.
A M & I W.American Manufacturer and Iron World. *w.* $4 per year. Pittsburg.
Am M....American Miller. *m.* $2. Chicago.
Am S....American Shipbuilder. *w.* $2. N. Y.
A A A....Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A H .....Annals of Hygiene. *m.* $2 per year. Phila.
A E .....Architectural Era. *m.* $3. N. Y.
A R .....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A & B....Architecture and Building. *w.* $6 N. Y.
A .....Arena. *m.* $5 per year. Boston.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
At M.....Atlantic Monthly. *m.* $4 per year. Boston.
B J C....Boston Journal of Commerce. *w.* $3 per year. Boston.
B & W....Builder and Woodworker. *m.* $1. N. Y.
B P .....Bulletin of Pharmacy. *m.* $1. Detroit.
C A .....Calif. Architect. *m.* $3. San Francisco.
Can A. ..Canadian Architect. *m.* $2. Toronto.
C E N....Canadian Electrical News. *m.* $1 per year. Toronto.
C & B....Carpentry and Building. *m.* $1. New York.
C M .....Century Magazine. *m.* $4 per year. N. Y.
Ch .....Chautauquan. *m.* $2. Meadville, Pa.
C E. .....Colliery Engineer. *m.* $2. Scranton, Pa.
C .....Compass. *m.* $2 per year. New York.
Cos.....Cosmopolitan. *m.* $3 per year. New York.
Cr.....Crank. *m.* $1.25 per year. Ithaca, N. Y.
D E.....Domestic Engineering. *m.* $1. Chicago.
D J ....Drainage Journal. *m.* $1. Indianapolis.
D Jour..Druggists' Journal. *m.* $1. Chicago.
E A .....Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3 per year. N. Y.
E I .....Electrical Industries. *m.* $3. Chicago.
E R N Y..Electrical Review. *w.* $3 per year. N. Y.
E W .....Electrical World. *w.* $3 per year. N. Y.
E N Y....Electricity. *w.* $2.50. N. Y.
E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
Eng .....Engineer. *s-m.* $2 per year. New York.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M .....Engineering Mechanics. *m.* $2. Phila.
E N .....Engineering News. *w.* $5 per year. N. Y.
E R .....Engineering Record. *w.* $5. N. Y.
F W .....Fire and Water. *w.* $3 per year. N. Y.
F .. ...Forum. *m.* $5 per year. New York.
G & F....Garden and Forest. *w.* $4 per year. N. Y
G G M...Goldthwaite's Geographical Magazine. *m* $2 per year. N. Y.
G R.....Good Roads. *m.* $2 per year. N. Y.
I A .....Inland Architect. *m* $5 per year. Chicago.
I R W...India Rubber World. *m.* $3 per year. N. Y.
I S F.....Industry. *m.* $2 per year. San Francisco.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. N. Y.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A .....Journal of Architecture.
J A C S..Journal of the American Chemical Society. *m.* $5 per year. N. Y.
J A E S. Journal of the Association of Engineering Societies. *m.* $3 per year. Chicago.
J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J M S I..Journal of the Military Service Institution. *b-m.* $4 per year. Governor's Island, N. Y. H.
J N E W..Journal of the N. E. Waterworks Association. *q.* $2. New London, Conn.
J U S A..Journal of the United States Artillery. *q.* $2.50. Fort Monroe, Va.
L M .....Leather Manufacturer. *m.* $3. N. Y.
L E .....Locomotive Engineering. *m.* $2. N. Y.
L P .....Louisiana Planter. *w.* $3. New Orleans.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M R .....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M N .....Mechanical News. *s-m.* $1.50. New York.
M & El...Mechanic and Electrician. *w.* $2 per year. St. Louis.
Met W...Metal Worker. *w.* $2 per year. N. Y.
Min .....Minerals. *m.* $1 per year. N. Y.
M S P ...Mining and Scientific Press. *w.* $3 per year. San Francisco, Cal.
M S R ...Mining and Scientific Review. *w.* $2 per year. Denver.
M I T....Mining Industry and Tradesman. *w.* $3 per year. Denver.
N B ....National Builder. *m.* $3. Chicago.
N C B...National Car Builder. *m.* $2. N. Y.
N A R...North American Review. *m.* $5. N. Y
N W .....Northwestern Architect. *m.* $3. Minneapolis.
N M ....Northwestern Mechanic. *m.* $1. Minneapolis.
O M .....Overland Monthly. *m.* $3 per year. San Francisco.
P L .....Pacific Lumberman, Contractor, and Electrician. *w.* $3. San Francisco.
P D ....Painting and Decorating. *m.* $1. Phila.
P M. ...Paper Mill. *w.* $3. N. Y.
P..... ..Paving and Municipal Engineering. *m.* $1 per year. Indianapolis.
P Era...Pharmaceutical Era. *s-m.* $2. Detroit.
P R .....Pharmaceutical Record. *s-m.* $1.50. N. Y.
P S N...Popular Science News. *m.* $1. Boston.
P S .....Power-Steam. *m.* $1 per year. N. Y.
P E. ...Practical Electricity. *f.* $2 per year. Boston.
P E C P..Proceedings of the Engineers' Club. *q.* $2 Phila.

P A .....Progressive Age. *s-m.* $3. New York.
R A E J..Railroad and Engineering Journal. *m.* $3 per year. New York.
R C J....Railroad Car Journal. *m.* $1 per year. N.Y.
R G .....Railroad Gazette. *w.* $4.20 per year. N. Y.
R A .....Railway Age. *w.* $4 per year. Chicago
R M M..Railway Master Mechanic. *m.* $1. Chicago.
R R.....Railway Review. *w.* $4 per year. Chicago.
R P .....Registered Pharmacist. *w.* $1. Chicago.
R M .....Roller Mill.
R & T...Roofer and Tinner. *m.* $1 per year, N. Y.
R T ....Rose Technic. *m.* $1. Terre Haute, Ind.
S V .....Safety Valve. *m.* $1 per year. N. Y.
San .....Sanitarian. *m.* $4 per year. Brooklyn.
S Era....Sanitary Era. *m.* $1 per year. N. Y.
S P .....Sanitary Plumber. *s-m.* $1. N. Y.
S M Q...School of Mines Quarterly. $2. N. Y.
Sc. .....Science. *w.* $3.50 per year. New York.
Sc A.....Scientific American. *w.* $3. N. Y.
S M .....Scientific Machinist. *m.* $1.50. Cleveland, O.
Sc M....Scribner's Magazine. *m.* $3. N. Y.
Sea.....Seaboard. *w.* $2 per year. N. Y.
S J C....Sibley Journal of Engineering. *m.* $2. Ithaca, N. Y.
S Ec.....Social Economist. *m.* $2. New York.
S A .....Southern Architect. *m.* $1. Atlanta.
S E .....Stationary Engineer. *w.* $2. Chicago.
S. .....Stone. *m.* $2 per year. Indianapolis, Ind.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R N...Street Railway News. *w.* $3. N. Y.
S R R....Street Railway Review. *m.* $1. Chicago.
T Q .....Technology Quarterly. $3. Boston.
T .....Trades-man *s-m.* $2. Chattanooga, Tenn.
T A I E E.Transactions American Institute of Electrical Engineers. *m.* $5 per year. N. Y.
T C E....Transactions American Society of Civil Engineers. *m.* $10. N. Y.
W E.....Western Electrician. *w.* $3. Chicago.

THE FOREIGN PRESS.

A M S ...Australian Mining Standard.
C T J....Chemical Trade Journal. *w.* 12*s.* 6*d.* per year, post-paid. Manchester, Eng.
C G.....Colliery Guardian. *w.* 27*s.* 6*d.* per year, post-paid. London.
C R .....Contemporary Review. *m.* $4.50 per year, New York. London.
D .....Discovery. *w.* 8*s.* 8*d.*, post-paid. London.
E E L....Electrical Engineer. *w.* 17*s.* 4*d.* per year. post-paid. London.
E P .....Electrical Plant. *m.* 6*s.* per year, post-paid. London.
E R L....Electrical Review. *w.* 21*s.* 8*d.* per year, post-paid. London.
El. .....Electrician. *w.* 24*s.* post-paid. London.
El P.....Electricien. *w.* 25 *fr.* post-paid. Paris.
Elec.....Electricité. *w.* 15 *fr.* post-paid. Paris.
E L .....Electricity. *w.* 6*s.* 6*d.*, post-paid. London.
Eng L....Engineer. *w.* 36*s.*, post-paid. London.
E. .....Engineering. *w.* 36*s.*, post-paid. London.
E G .....Engineers' Gazette. *m.* 4*s.*, post-paid. London.
F R .....Fortnightly Review. *m.* $4.50 per year. New York. London.
G E M...Gas Engineers' Magazine. *m.* 6*s.* 6*d.* per year, post-paid. Birmingham, Eng.
G W .....Gas World. *w.* 13*s.*, post-paid. London.
G C .....Génie Civil. *w.* 45 *fr.*, post-paid. Paris.
I C B....Illustrated Carpenter and Builder. *w.* 8*s.* 8*d.* per year, post-paid. London.
I E .....Indian Engineering. *w.* Rs. 18 per year, postage extra. Calcutta.
I L. .....Industries. *w.* 32*s.*, post-paid. London.
Inv. .....Invention. *w.* 28*s.*, post-paid. London.
I. .....Iron. *w.* 30*s.* per year, post-paid. London.
J G L....Journal of Gas Lighting. London.
J S A....Journal of the Society of Arts. *w.* London.
K .....Knowledge. *m.* 6*s.*, post-paid. London.
M .....Machinery. *m.* 9*s.*, post-paid. London.
M E & E J. Manufacturers' Engineering and Export Journal. *m.* London.
M E .....Marine Engineer. *m.* 7*s.* 6*d.* per year, post-paid. London.
M W. ...Mechanical World. *w.* 8*s.* 8*d.* per year, post-paid. London.
M I .....Moniteur Industriel. 3 times a week. 40 *fr.* per year, post-paid. Paris.
N. .....Nature. *w.* $7, post-paid. London.
N C .....Nineteenth Century. *m.* $4.50 per year. New York. London.
P Eng...Practical Engineer. *w.* 10*s.* per year, post-paid. London.
R N .....Railway News. London.
R W .....Railway World. *m.* $3, post-paid. London.
Rev R...Review of Reviews. *m.* $2.50. New York. London.
R U M...Revue Universelle des Mines. *m.* 40 *fr.* per year, post-paid. Paris.
S R .....Sanitary Record. *m.* London.
S L .....Steamship. *m.* Leith, Scotland.
W R .....Westminster Review. *m.* $4.50 per year. N. Y. London.

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*7392. Electric Light and Power. V. Arthur F. Guy (E E L-Oct. 7.) 3500 w.

*7393 On the Manufacture of Incandescent Electric Lamps. Frederick Graham Ansell (E E L-Oct. 7.) 2300 w.

*7401 Portable Miners' Electric Lamps. Sydney F. Walker (C G-Oct. 7.) 2000 w.

7453. A Visit to the Westinghouse Electric Works at Pittsburgh. Ill. Jos. Wetzler (E E N Y-Oct. 19.) 7000 w.

*7527. Notes on the Fitting up of Ships with the Electric Light. III. Ill. Alfred H. Gibbings (E L-Oct. 14.) 2500 w.

*7618. Underground Mains in Paris. M. G. Claude (El-Oct. 21.) 2200 w.

*7619. The Age-Coating in Incandescent Lamps. Ill. Edward L. Nichols (El-Oct. 21.) 1900 w.

*7620. Electric Light and Power. VI. Arthur F. Guy (E E L-Oct. 21.) 2000 w.

*7633. Notes on the Fitting up of Ships with the Electric Light. IV. Ill. Alfred H. Gibbings (E L-Oct. 21.) 1400 w.

*7635. Electric Light Installation at the People's Palace. Ill. (E-Oct. 21.) 1800 w.

7676. A Novel Application of Electric Lighting to Church Illumination (E R N Y-Nov. 5.) 700 w.

7703. The Lighting of Fifth Avenue, New York. Jos. Wetzler (E E N Y-Nov. 2.) 900 w.

7785. The Guelph Electric Light Company. Ill. (C E N-Nov.) 1000 w.

*7799. Practical Electrical Units. III. (M W-Oct. 28.) 1700 w.

*7802. Notes on the Fitting up of Ships with the Electric Light. V. Alfred H. Gibbings (E L-Oct. 28.) 1000 w.

*7831. La Lampe à Arc Mariotti. Ill. A. Palaz (El P–Oct. 8.) 500 w.

*7832. L'Eclairage Electrique de Perpignan. Ill. Ch. Haubtmann (El P–Oct. 15.) 3300 w.

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*7857. Wanted—A Meter for the Million (E R L–Oct. 28.) 1200 w.

7875 The First Electric Lightship—The Electric Equipment of "No. 51." Ill. G. B. Muldaur (E E N Y–Nov. 9.) 1200 w.

7878. The Use of Storage Batteries in Central Stations Abroad. R. E. Crompton (E E N Y–Nov. 9.) 1200 w.

*7898. Electric Lighting in Milan. Ill. (E P–Nov 1.) 800 w.

†7936. Long Distance Transmission for Lighting and Power. Ill. Charles F. Scott (T A I E E–July-Aug.) 5700 w.

*7951. Electric Lighting at Cambridge. Ill. (E–Nov. 4.) 7000 w.

*7956. St. Pancras Electricity Supply—The Cheap Daylight Service. Ill. (E R L–Nov. 4.) 1500 w.

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*7989. Notes on the Fitting up of Ships with the Electric Light. VI. Ill. Alfred H. Gibbings (E L–Nov. 4.) 2000 w.

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7414. Krehbiel Sectional Coach and Drawing-Room Sleeper. Ill. (R R–Oct. 15.) 1400 w.

7416. Rate-Making and Rate Maintenance. Editorial (R R–Oct. 15.) 850 w.

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7418. Baltimore & Ohio Lumber Car. Ill. (R R–Oct. 15.) 500 w.

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7446. Distant Signals and the Fitchburg Collision (E N–Oct. 20.) 1300 w.

7447. The Transportation of Great Crowds (E N–Oct. 20.) 1000 w.

7451. Guard Wires for Electric Railways. Frank B. Rae (E E N Y–Oct. 19.) 700 w.

7452. The Comparative Efficiency of the Commutated Field and the External Resistance for Controlling Railway Switches. Harold R. Wellman (E E N Y–Oct. 19.) 500 w.

*7455. Papaghni Bridge, Madras Railway (I E–Sept. 17.) 1200 w.

*7456. The Locomotive Boiler. I. Gustave Richard (A J R A–Oct.) 1800 w.

*7457. Standard Six-Wheeled Underframe and European Draft Rigging. Ill. (A J R A–Oct.) 2500 w.

7463. Comparative Cost of Carrying Passengers on Street Roads (M S P–Oct. 15.) 550 w.

7470. Signaling Regulations on German Railroads (R G–Oct. 21.) 1500 w.

7471. Do Big Excursions Pay? Editorial (R G–Oct. 21.) 1300 w.

7484. Passenger Rates for the World's Fair (R A–Oct. 21.) 700 w.

7485. Railway Signaling. Report to the Superintendents' Association (R A–Oct. 21.) 2500 w.

7506. The Siberian Railway (R R–Oct. 22.) 1200 w.

7507. The Proper Method of Handling Bulk Shipments. Editorial (R R–Oct. 22.) 950 w.

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7509. Chicago, Milwaukee, and St. Paul Freight Yard at Galewood Station. Ill. (R R–Oct. 22.) 600 w.

7510. A Catechism for Railway Employés (R R–Oct. 22.) 5000 w.

7511. A Probe at the Problem. Geo. De Haven (R R–Oct. 22.) 4500 w.

7512. The Western Cable Railway. Ill. (A S–Oct. 22.) 1500 w.

*7520. Locomotives in New South Wales. Letter from Neilson & Co. (Eng L–Oct. 14.) 5000 w.

7531. Cost of Electric vs. Steam Railroads. Editorial (E W–Oct. 29.) 950 w.

7533. A Perfect Overhead Electric Construction. Chas. H. Smith (E W–Oct. 29.) 1100 w.

7534. Is a Standard Rail Head Possible? John F. Ostrom (E W–Oct. 29.) 1100 w.

7535. Economy of Machine Shops for Electric Street Railways. John F. Bickford (E W–Oct. 29.) 2200 w.

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7537. Standards for Electric Street Railways. O. T. Crosby (E W–Oct. 29.) 2500 w.

7538. Relative Cost of Operation of Horse, Cable, and Electric Roads. Wm. M. Ramsey, Frank R. Greene, and John L. Heins (E W–Oct. 29.) 2000 w.

7539. A Model Electric Street Railway Roadbed and Underground Wiring. Geo. W. Baumhoff (E W–Oct. 29.) 4500 w.

†7544 Barsi Steam Tramway (I E–Sept. 24.) 1400 w.

7562. The Use of Traction Engines in England. Ill. William Fletcher (E N–Oct. 27.) 2800 w.

†7586. Fare Taking in Europe (S R J–Nov.) 800 w.

†7587. The Milwaukee Street Railway System. Ill. (S R J–Nov.) 2000 w.

†7588. Cable Construction on Third Avenue, New York. Ill. (S R J–Nov.) 850 w.

†7589. Adaptation of the Cable System to Swing Bridges. Ill. (S R J–Nov.) 400 w.

†7590. The New Cable Station of the West Chicago Street Railway Co. Ill. (S R J–Nov.) 1500 w.

†7591. Street Car Fenders in Boston. Ill. (S R J–Nov.) 600 w.

†7592. Some European and American Methods Compared. G. Herbert Condict (S R J–Nov.) 750 w.

7593. The Equipment of the "Alley" Elevated Road, Chicago. Ill. (R G–Oct. 28.) 5000 w.

7594. Ohio Extension of the Norfolk and Western Railroad. Ill. (R G–Oct. 28.) 1500 w.

7596. Track Tanks on the Baltimore and Ohio (R G–Oct. 28.) 1400 w.

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7598. The Long and Short Haul Controversy, and Judge Brewer's Decision (R G–Oct. 28.) 3000 w.

*7599. Isthmian Railways (R M–Oct.) 1000 w.

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7604. Two Electric Railway Conduit Systems. Ill. (S R R–Oct.) 900 w.

7605. The City and Suburban Railway of Portland, Oregon. Ill. (S R R–Oct.) 1500 w.

7606. The Genett Air Brake for Street Railway Cars. Ill. (S R R–Oct.) 700 w.

7608. Inefficiency of Brakes. E. J. (R M M–Nov.) 800 w.

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7623. Interstate Commerce Commission vs. Texas and Pacific Railway (R A–Oct. 28.) 2000 w.

7624. Device for "Taking Down" Brake Cylinders. Ill. (R A–Oct. 28.) 500 w.

*7638. New South Wales Railways. Editorial (E–Oct. 21.) 1400 w.

*7644. Converted Great Western Locomotives. Ill. (Eng L–Oct. 21.) 1000 w.

*7647. Flexible Locomotives. Editorial (Eng L–Oct. 21.) 1800 w.

*7669. Fuel Saving Effected by Close Notched Quadrants. R. W. Gray (N C B–Nov.) 500 w.

*7670. Air Brake Testing Apparatus. Ill. (N C B–Nov.) 1200 w.

*7671. Big Locomotive Wheels (R A E J–Nov.) 2000 w.

*7672. A New York Central Fast Locomotive. Ill. (R A E J–Nov.) 400 w.

*7673. The Locomotive "Cornwall." Ill. (R A E J–Nov.) 150 w.

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†7695. Test of Power Required to Drive Electric Street Cars, and Total Efficiency of Motor. Louis B. Bonnett (T C E–Sept.) 1800 w.

†7696. Motive Power for Street Railways. Alfred F. Sears (T C E–Sept.) 4000 w.

*7697. The Protection from Corrosion of Ironwork Used as Covering for Railroad Tunnels, with Discussion. Ill. James G. Dagron (T C E–Sept.) 1500 w.

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*7711. The Steepest Railroad in the World—2,534.40 Feet per Mile—48 Feet in 100, or 48 Per Cent. Ill. (L E–Nov.) 800 w.

*7712. Weak Features of Freight Cars. Editorial (L E–Nov.) 900 w.

*7713. Some Reasons Why English Roads Will Never Adopt the Long American Freight Car. Editorial (L E–Nov.) 700 w.

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7787. Railroad Motive Power. III. D. (S M–Oct. 15.) 1200 w.

*7797. Grand Trunk Railway of Canada. Ill. (R W–Nov.) 1800 w.

*7798. The Proposed Underground Electric Railway in Berlin. Ill. (R W–Nov.) 300 w.

*7828. Chemins de Fer Electriques (Elec–Oct. 27.) 1800 w.

*7830. L'Electricité dans les Chemins de Fer Français. Exploitation par le Block-System. I. Ill. Camille Grollet (El P–Oct. 8.) 5000 w.

7846. State Interference with Interstate Commerce. Editorial (R R–Nov. 5.) 1200 w.

7847. Electric Signaling Apparatus. Ill. (R R–Nov. 5.) 700 w.

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†7942. Series Electric Traction. Nelson W. Perry (T A I E E–July-Aug.) 5500 w.

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7946. Car Wheels. Ill. E. L. Taylor (A M & I W–Nov. 11.) 2000 w.

*7952. Railways in Queensland. Editorial (E–Nov. 4.) 1200 w.

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7962. Notes on the Block System. W. L. Derr (R A–Nov. 11.) 3000 w.

*7999. Signaux de Chemins de Fer. "El." (M I–Nov. 1.) 900 w.

*8006. Pousse-Wagon, Système Saint-Martin. Ill. (G C–Oct. 29.) 700 w.

8010. New Track of the Prussian State Railway. Ill. (R R–Nov. 12.) 1500 w.

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*8016. The Mount Pilatus Railway. Ill. (A J R A–Nov.) 650 w.

*8017. The Lehigh Valley Railroad (A J R A–Nov.) 1300 w.

*8018. The Locomotive Boiler. II. Gustav Richard (A J R A–Nov.) 2200 w.

*8019. Train Shed, South Brooklyn Terminal Railway Company. Ill. (A J R A–Nov.) 700 w.

*8020. Standard Culverts, Lake Shore and Michigan Southern Railway. Ill. (A J R A–Nov.) 350 w.

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*7383. Purification of Sewage by Microbes. Editorial (E–Oct. 7.) 2000 w.

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7445. Sewage Purification in America. XII. Ill. (E N–Oct. 20.) 1200 w.

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7478. London's Purified Thames (F W–Oct. 22.) 900 w.

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7481. Progress of Sanitary Engineering. James Lemon (A & B–Oct. 22.) 1900 w.

7482. English Homes. Thomas Crawford (A & B–Oct. 22.) 1000 w.

†7488. Quarantine at New York. William T. Jenkins (N A R–Nov.) 2500 w.

†7489. Sanitation vs. Quarantine. Thomas P. Hughes (N A R–Nov.) 1200 w.

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*7549. Ventilation, Heating, and Lighting (S R–Oct. 15.) 1100 w.

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†7689. The Status of Sanitation in the United States as Indicated by the Most Recent Official Reports and Other Sources of Information. Harry Kent Bell (San–Nov.) 4000 w.

*7699. Public Sanitary Aid Indispensable to the General Health. Howard S. Anders (A H–Nov.) 3000 w.

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*7812. Le Léman à Paris. L'Assainissement du Bassin de la Seine par l'Eau Surabondante à Bon Marché en 1899. Ill. I. A. Lesévrien (G C–Oct. 8.) 3800 w.

*7815. Le Léman à Paris. L'Assainissement du Bassin de la Seine par l'Eau Surabondante à Bon Marché en 1899. II. A. Lesévrien (G C–Oct. 15.) 4700 w.

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7960. Wolverhampton, England. Sewage (E R–Nov. 12.) 700 w.

*8003. Le Léman à Paris. L'Assainissement du Bassin de la Seine par l'Eau Surabondante à Bon Marché en 1899. IV. A. Lesévrien (G C–Oct. 29.) 4500 w.

*8004. Le Tout-à-l'Egout. Expuration Chimique et Electrique des Eaux-Vannes. Max de Nansouty (G C–Oct. 29.) 1700 w.

STEAM ENGINEERING.

*7369. A. R. Sennett on Smoke Prevention. Ill. W. H. Booth (E R L–Oct. 7.) 1800 w.

*7400. Applications of Super-heated Steam for Steam Engines (C G–Oct. 7.) 1400 w.

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*7493. Winding Engines for the East Elliot Pit of the Powell-Duffryn Colliery Company. Ill. (E–Oct. 14.) 600 w.

7557. Boiler Tests. Chas. H. Garlick (S E–Oct. 22.) 1000 w.

*7602. A Probable Cause of Boiler Explosions (R M–Oct.) 1000 w.

7607. Boiler Scale and its Effect upon Fuel Economy. E. M. Herr (R M M–Nov.) 500 w.

7642. The Waste of Coal—Abstract of Lecture by Wm. Kent (Eng–Oct. 29.) 1100 w.

*7734. Test of the Power Plant of the Utica (N. Y.) Steam Cotton Mills. Ill. R. C. Carpenter (S J E–Oct.) 2300 w.

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*7858. Economics of the "Automatic" Engine (E R L–Oct. 28.) 1600 w.

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*7870. Friction of Cotton Mill Engines and Gearing. Alfred Saxon (P Eng–Oct. 28. 4500 w.

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7983. The Economy of Coal Fuel. I. I. Bowe (Eng–Nov. 12.) 1200 w.

*8000. Utilisation Rationnelle de la Vapeur en Sucrerie. Th. Cambier (M I–Nov. 1.) 3800 w.

*8005. Nouvelle Chaudière à Vapeur Système le Moai. Ill. Henri Mamy (G C–Oct. 29.) 700 w.

TELEPHONY AND TELEGRAPHY.

*7373. Notes on Submarine Cable Work. IV. Ill. H. D. Wilkinson (El–Oct. 7.) 2500 w.

*7376. Propagation of the Current in a Cable Containing Distributed Static Capacity and Self-Induction. I. Frederick Bedell and Albert C. Crehore (El–Oct. 7.) 2800 w.

*7516. Propagation of the Current in a Cable Containing Distributed Static Capacity and Self-Induction. II. Frederick Bedell and Albert C. Crehore (El–Oct. 14.) 2500 w.

*7517. Cable Relays. Ill. Walter Judd (El–Oct. 14.) 900 w.

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7719. Proposed Cable between the United States and China. Ill. Romyn Hitchcock (E A–Nov. 5.) 1500 w.

*7803. The Gibboney-Thomson Telephone System. Ill. (E L–Oct. 28) 1500 w.

*7836. Le Système Téléphonique Gibboney-Thomson. Ill. E. Meylan (El P–Oct. 22.) 2200 w.

*7837. La Fabrication en France des Cables Sous-Marins. Ill. J. A. Montpellier (El P–Oct. 29.) 3300 w.

7845. Observations on the Use of Bronze Wire in Telegraphy (E R N Y–Nov. 12.) 1000 w.

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*7970. Notes on Submarine Cable Work. V. Ill. H. D. Wilkinson (El–Nov. 4.) 1500 w.

*7971. Bare Copper Underground Conductors. R. E. Crompton (El–Nov. 4.) 800 w.

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*7353. Industrial Development of the South. III. Types of Recent Progress. R. H. Edmonds (E Mag–Dec.) 3000 w.

*7354. Our Remaining Hard-Wood Resources. Charles Mohr (E Mag–Dec.) 3000 w.

*7358. The World's Fair and the Death Rate of 1893. James C. Bayles (E Mag–Dec.) 3000 w.

*7361. Inland Navigation in France. I. (Eng L–Oct. 7.) 2500 w.

*7362. The Compression of Gases. Editorial (Eng L–Oct. 7.) 2000 w.

†7367. McKinleyism and the Presidential Election. Robert Donald (C R–Oct.) 7000 w.

†7420. Progress in Aerial Navigation. Hiram S. Maxim (F R–Oct.) 6500 w.

7435. A New Air Ship. Ill. (Sc A–Oct. 22.) 600 w.

7444. Rainfall, Flow of Streams, and Storage. Ill. (E N–Oct. 20.) 2500 w.

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7474. Wiborgh's Air Pyrometer. Ill. (E M J –Oct. 22.) 450 w.

7476. Short History of Lake Navigation. V. C. H. Keep (M R C–Oct. 20.) 2000 w.

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*7505. The Walker Engineering Laboratories. Ill. (I–Oct. 14.) 4000 w.

*7518. Niagara Mastered (Eng L–Oct. 14.) 3000 w.

*7525. Aerial Navigation. Ill. John P. Holland (Cos–Nov.) 4000 w.

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*7530. Does Dynamite Break Down? Wm. L. Saunders (S–Oct.) 1400 w.

*7554. The Warming of Town Buildings. Suggestions for a Conference (J G L–Oct. 18.) 2000 w.

*7555. The Illumination of Lighthouses. John R. Wigham (J G L–Oct. 18.) 2000 w.

7559. The Erie Canal Convention at Buffalo. Ill. (Sea–Oct. 27.) 1400 w.

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*7567. Chicago's Part in the World's Fair. Franklin Mac Veagh (Sc M–Nov.) 5000 w.

7631. High Buildings. Their Internal and Exterior Hazard from Fire. D. J. Swenie (F W–Oct. 29) 2000 w.

*7643. Inland Navigation in France. II. Ill. (Eng L–Oct. 21.) 3300 w.

*7649. Technical Education. A. Denny (I L–Oct. 21.) 4500 w.

*7650. The Haulage of Canal Boats, and Mons. de Bovet's Magnetic Pulleys. Ill. G. Pellissier (E R L–Oct. 21) 3000 w.

†7687. National Health Legislation and Quarantine. H. P. Wolcott (San–Nov.) 1800 w.

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7733. A Lake Naval Reserve Needed. Editorial (Sea–Nov. 3.) 1000 w.

7747. Ships and Ship-building on the Great Lakes. I. (R G–Nov. 4.) 1500 w.

†7752. Evaporation by Multiple Effect. Ill. Teile Henry Müller (P E C P–Oct.) 10,000 w.

†7754. The Influence of Rainfall on Commercial Development: A Study of the Arid Region. Jacques W. Redway (P E C P–Oct.) 4500 w.

*7759. Who Pays the Tariff (S Ec–Nov.) 3000 w.

*7760. The Art of Decorative Composition. I. Ill. (A E–Oct.) 900 w.

*7813. Compresseur d'Air Système Galland et Levet. Ill. F. Desquiens (G C–Oct. 8.) 1400 w.

*7827. Etude sur la Gutta-Percha. I. Léon Brasse (Elec–Oct. 20.) 2100 w.

*7869. On Some Forms of Petroleum Engines. II. Ill. (P Eng–Oct. 28.) 1200 w.

*7884. The Coal Supply of Paris—Its Origin and Transport (C G–Oct. 28.) 1200 w.

*7885. New Method of Burning Bricks. M. Edouard Blanc (C G–Oct. 28.) 1000 w.

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7910. Engineering Schools of the United States. XXXI. (E N–Nov. 10.) 1400 w.

7926. The Effect of the Fair Buildings in Chicago (A A–Nov. 12.) 3800 w.

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*7979. On Some Forms of Petroleum Engines. III. Ill. (P Eng–Nov. 4.) 900 w.

*7980. Inaugural Address of Prof. Archibald Barr—President of Glasgow University Engineering Society. I. (P Eng–Nov. 4.) 2000 w.

†7992. The Manufacture of Rubber Varnish. Ralph W. Gray (I R W–Nov. 15.) 900 w

†7993. The Influence of Additions to Rubber (I R W–Nov. 15.) 550 w.

NEW BOOKS OF THE MONTH.

[For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Badoureau, A., and Grangier, P.=Les Mines, les Minières, et les Carrières. Paris: May et Motteroz [8vo, paper, 331 p., 5 *fr.*]

Berthelot, M.=Explosives and Their Power. Translated from the French by C. Napier Hake and Wm. McNab. With preface by J. P. Cundill. [8vo, cloth, 554 p., 24*s.*]

Bjorling, Philip R.=The Construction of Pump Details. New York: Spon. [16mo, cloth, 208 p., $3.]

Cracker, F. B., and Wheeler, S. S.=The Practical Management of Dynamos and Motors. New York: Van Nostrand. [12mo, cloth, 38 p., $1.]

Davis, R. Harding, Lang, Andrew, and others.=The Great Streets of the World. New York: Scribner. [8vo, cloth, 261 p., $4.]

Donaudy, J.=Note sur l'Ascenseur Télescopique, du Système Samain, Etabli à l'Hôtel de la Compagnie des Docks et Entrepots de Marseille. Marseilles: Impr. Barlatier et Barthelet. [8vo, paper, 16 p.]

Ferree, Barr.=Comparative Architecture. New York: American Institute of Architects. [8vo, paper, 15 p.]

Fleming, J. A.=The Alternate Current Transformer in Theory and Practice. Vol. II. The Utilization of Induced Currents. New York: Van Nostrand. [8vo, cloth, 607 p., $5.]

Frederick, F. F.=Architectural Rendering in Sepia. New York: Comstock. [Folio, cloth, 40 p., $3.]

Hughes, H. W.=A Text-Book of Coal-Mining. London: Griffin. [8vo, cloth, 448 p., 18*s.*]

Jaynson, F.=The Iron and Steel Maker: being detailed descriptions of the various processes for the conversion of the ores of iron into pig iron or cast iron, wrought or malleable iron, and the different qualities of steel. New York: Ward, Lock, Bowden & Co. [8vo, cloth, 447 p., $2.]

Kennedy, Alex. B. W.=Compressed Air: experiments upon the transmission of power by compressed air in Paris (Popp's system). New York: Van Nostrand. [16mo, boards, 124 p., 50c.]

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